JOURNAL

OF THE

ROYAL GEOLOGICAL SOCIETY

OF IRELAND.

VOL. I.

1864–67.

LONDON:
WILLIAMS & NORGATE,
14, HENRIETTA-ST., COVENT GARDEN.

DUBLIN:
HODGES, SMITH, AND CO.,
104, GRAFTON-STREET.

EDINBURGH:
WILLIAMS & NORGATE, 20, SOUTH FREDERICK-STREET.

1867.

DUBLIN:
Printed at the University Press,
BY M. H. GILL.

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JOURNAL

OF THE

ROYAL GEOLOGICAL SOCIETY OF IRELAND.

I.—Report of Council.

[Read at the General Meeting, April 15, 1864.]

The idea has been frequently mooted within the last few years, that it would be advisable to have the name of the Society altered, so as to make it the Geological Society of Ireland, as the title Geological Society of Dublin appears to confine its labours to the immediate vicinity of this city; whereas by the original resolution, passed in 1832, its objects were so defined as to embrace the whole of Ireland. In addition to this change, several influential members were of opinion that the addition of the word "Royal" to its title would be of great importance, as indicating that Her Majesty was disposed to recognise its labours. The Council accordingly, at their meeting on the 17th of February, appointed a sub-committee, consisting of the Rev. Professor Haughton, with the Treasurers and Secretaries, with full powers to act as they thought best. The sub-committee drew up a memorial, which was suitably engrossed, and they requested the following members to sign it:—The Earls of Enniskillen, Bandon, and Dunraven; Lords Talbot de Malahide and Dunally; Sir R. Griffith, Bart., with the President. They further requested Lord Talbot de Malahide, as a former President of the Society, to have the kindness to forward the memorial to the Home Office, and they enclosed with it a complete copy of the "Journal" for Her Majesty's acceptance. The Council have the honour to submit the reply which Her Majesty has been graciously pleased to return to their memorial; and they cannot but, in the first instance, congratulate the Society on this proof that their labours during the past thirty years have been appreciated as they would consider they deserve to be; and, secondly, express a hope that the fact of the recognition of this body as the "Royal Geological Society of Ireland" may incite the Fellows to still further exertion in the cause of their favourite science. In conclu-

sion, the Council desire to tender their most sincere thanks to Lord Talbot de Malahide, to whose kindness they consider themselves mainly indebted for the successful issue to which their application has been brought. They would also express their warmest acknowledgments to Mr. Robert Mallet, F. R. S., who, though no longer resident in Dublin, is still unremitting in his interest in the Society, of which he has been so long a distinguished member, and whose unceasing exertions in regard to this special accession of dignity to it have at last been crowned with success:—

"*Whitehall, March* 28, 1864.

"My Lord,—I have had the honour to lay before the Queen the petition, transmitted in your letter of the 17th instant, of certain members of the Geological Society of Dublin, on behalf of that Society, and I am to inform your Lordship that Her Majesty has been graciously pleased to comply with the prayer of the petition, and to signify her desire that the Geological Society of Dublin be henceforth called 'The Royal Geological Society of Ireland;' and that the members thereof be styled 'Fellows of the Royal Geological Society of Ireland.' I am commanded by Her Majesty to convey to the Society her thanks for the copy of the Journal of their Proceedings forwarded by your Lordship, which has been placed in the Royal Library at Windsor.

"I have the honour to be, my Lord,

"Your Lordship's obedient servant,

(Signed) "G. Grey.

"*The Lord Talbot de Malahide.*"

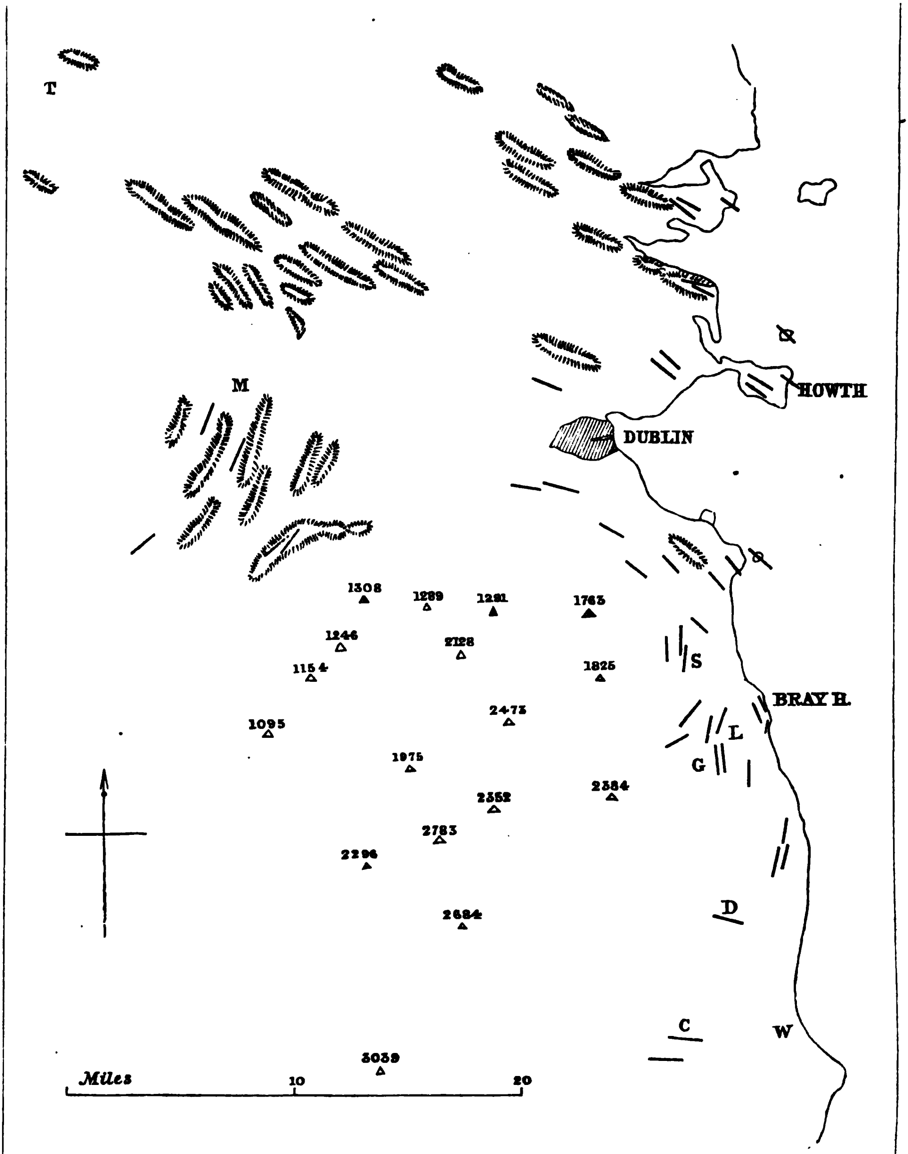
Mr. Jukes proposed, "That the marked thanks of the Society are due, and are hereby given, to Lord Talbot de Malahide and the other noblemen and gentlemen mentioned in the Report just read, for their exertions and kindness in aiding the memorial with the sanction of their names; and also to their old and esteemed Fellow, Mr. Robert Mallet, for his unceasing efforts, which at last had resulted in giving the Society such a very great advancement in position and dignity as compared with that which it had held before."

Dr. Sidney seconded the motion.

The President said,—In putting this motion to the meeting, which I have no doubt will be received with the pleasure it deserves, I cannot refrain from giving my own congratulations to the Fellows on the occasion of the new honour which has just been conferred upon us; and the more so, because, as Mr. Jukes has just said, it is really an acknowledgment of the labours of the Society for the past thirty years. Were I myself a working geologist, I should not venture to say what I do say now, which is, that all our strength is derived from the working members of our body, and from the valuable information derived from such men as Professor Jukes and the Professor of Geology in this University. Were it not for their aid we could not have raised ourselves to the position which we now occupy. I have, therefore, to request you to pass the vote of thanks.

The motion was passed by acclamation.

It was proposed by Dr. Sidney, and seconded by Mr. Sanders, "That it be referred to Council to consider whether any, and, if so, what changes in the By-laws may be rendered necessary by the change in the constitution of the Society which has been announced this evening."



MAP OF GLACIAL PHENOMENA NEAR DUBLIN.

The short strokes give the directions of the rock-striations. On this small scale the ridging can only be represented diagrammatically.

S.	Summit of Shankill, 912 ft.	M.	Maynooth.
G.	„ Great Sugar-loaf, 1659	W.	Wicklow.
L.	„ Little do. 1120	T.	Trim.
D.	„ Dunran Hill, 1122		
C.	„ Carrick Hill, 1252		

TO ILLUSTRATE MR. CLOSE'S PAPER ON "GLACIATION."

II.—Notes on the General Glaciation of the Rocks in the Neighbourhood of Dublin. By the Rev. Maxwell H. Close.

[Read May 11, 1864.]

It has long been known that the phenomena of rounding, smoothing, and scoring of rock surfaces, now almost universally attributed to the action of ice in some shape or other, are well exhibited in different localities round Dublin. In the "Journal" of our Society, and in the Explanations of Sheets 102 and 112 of the Geological Survey Maps, striations and other marks of abrasion are recorded as occurring on the rocks in several places along the Drogheda Railway, on Lambay Island, at Howth, at Killiney, and on Bray Head.* Many of the particulars about to be described have been, I know, observed by different persons; but I am not aware that any tolerably *connected* account of them has been given. Some such connected and sufficiently detailed account is, from the nature of the case, often necessary to secure the correct interpretation of the phenomenon in hand at particular places.

This paper treats especially of the *general* Glaciation of the neighbourhood. The subject presents in this district two points of particular interest. The general glacial stream has here invaded what was doubtless the domain of the local ice-system of the Dublin and Wicklow mountains; and the relations of the two might be here ascertained, if we had sufficient evidence to go upon; and, moreover, it is interesting to observe, as the evidence fully enables us to observe, how the current, after passing across a considerable extent of plain country, has been affected by the obstruction of the mountains.

It seems best to state at once, though reasons cannot now be given without anticipating, that this paper has been written under the conviction that that current consisted of *glacier* ice, which probably covered the greater part of the country, and hereabouts came from the W. N. W.

The small accompanying map, Plate I., will give a tolerable general idea of the phenomena in question, but it may be well to point out more in detail the places where those phenomena present themselves. In giving the directions (true, not magnetic) of the striations, &c., it will be sufficient to set down the points *from* which they run.

In the railway cutting at Donabate, at a short distance from the station, on both sides of the railway, but especially on the western, where is the fairest example, scorings occur on the greenstone, direction

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* It is necessary to note an evident typographical error in our "Journal," vol. iii., p. 61. Professor Oldham is there made to say, in an abstract of a paper by him, that he found rock scorings on Bray Head, N. 23° E., and S. 23° W. This has misled Mr. Jamieson ("Journal of the Geological Society," London, 1862) into supposing that that part of the country has been swept by ice from the bed of the Irish Channel. It is certainly true that at one place, under the lee side of the hill, the striations have curved round almost into that direction; but on comparing this with another paper, by Professor Oldham, vol. iii., p. 132, it will be seen that he must have written N. 23° W., and S. 23° E.; which is the direction of some good grinding to be seen on the upper part of Bray Head.

N. 57° W. In the churchyard of the Roman Catholic chapel at Donabate, on Old Red Sandstone conglomerate, the mean or normal direction is about N. 70° W. On the shore at Portrane, on Silurian slaty rock, the striations are to be seen peeping out from under the bank of drift: owing to the inequalities of the surface, they vary a little on each side of the mean direction, N. 66° W.; at one spot they run nearly at right angles to this, affording, apparently, one of the very few examples of cross striations. In the large quarry, one-fifth of a mile S. S. E. of the town of Malahide, on Carboniferous Limestone, the direction is N. 82° W.; and in two small quarries, three-fourths of a mile S. E. of the town, on the same rock, the normal direction is the same. On the island of Ireland's Eye the masses of vein-quartz occurring in the Cambrian quartz rock are, in many places, well polished and striated; direction N. 63° W. On the Hill of Howth, not merely the vein-quartz, but the Cambrian quartz rock itself and the grits and slates have well retained, in many places, the marks of grinding, in the rounding, smoothing, and scoring of the surface. Striations are to be seen at one-fourth of a mile east of St. Fintan's Church; at a short distance south of the summit of Kilmartin Hill, at an elevation of 500 feet; on the top of Carrickbrack Hill, a very good example; near Drumleck Point, elevation about 40 feet; a little to the north, and also to the south of Kitestown; at one-fourth of a mile S.W. of Casana Rock, where the striations (to be referred to again) run *down hill;* near the Nose of Howth; and, as I am informed by Mr. Westropp, on the shore near Sutton Station, the rock in this case being Carboniferous Limestone. The striations are remarkably parallel over the whole of the peninsula, whether on the level ground, at the top, or on the sides; the normal direction for the hill being just about N. 60° W. In a large quarry half a mile north of Raheny, and in a small quarry seven-eighths of a mile north of the same place, the limestone is scored in the direction N. 48° W. In a quarry three-eighths of a mile due north of Finglas Bridge, the same rock has striations whose normal direction is N. 64° W.

In all the cases now mentioned the striations have a very striking nearness of direction; their variations are entirely due to immediately local inequalities of surface. Turn we now to the south of Dublin, where we shall find great changes of direction connected with the larger physical features of the district. At one-eighth of a mile S. E. of Crumlin House the rock is limestone, striations N. 82° W. At three-eighths of a mile N. by E. of the cross-roads at Roundtown the same rock has scorings N. 74° W. At Dundrum, just to the south of the church, the granite is well rounded and scored, N. 60° W. In different places near Murphystown, granite, N. 54° W. At Stillorgan reservoir, and in different places about Foxrock, granite, N. 43° W. The normal direction of the striations on the three Killiney Hills (granite and mica slate) seems to be precisely the same as the last. A most striking example of grinding occurs just outside the N.W. corner of Killiney Park on the southern slope of Rochestown Hill. Besides scorings covering many square yards of mica slate and granite, there is a straight groove or moulding, nearly two yards

long, nine inches wide, and 2½ inches deep. This and the parallel scorings run obliquely across the edges of the highly inclined beds of mica slate. Some small masses of quartz, having better resisted the abrasion, stand up a little from the surface, and have given rise to some miniature specimens of "crag and tail," which show not merely the line of the grinding, but the direction of the motion in that line. On the same hill are many striking *roches moutonnées*, but of these we shall speak again. Marks of grinding occur likewise on the middle, or Killiney Hill proper. On the N.E. shoulder of Dalkey Hill the striations can be seen near a wall opposite Ardsunnas Cottage, on the granite; also in a small quarry one-fourth of a mile N. E. of the summit of the hill, running straight up the hill; to be referred to again. At a short distance N. and N. E. and S. of Ballycorus chimney shaft the normal direction of the scorings, on mica slate and vein-quartz in granite, is due north, elevation 760 feet. In three or four different places in the wood on the east side of the Scalp the direction, on granite vein-quartz, is the same. Obscure but indubitable traces of grinding can be seen on the upper parts of the sides of the Scalp itself, showing that the current has flowed through that gorge. On the summit (912 feet) and sides of the knob which forms the top of Carriggologan Hill, or Shankill, on Cambrian quartz rock, especially on the quartz veins, the smoothing and striation still survive; the normal direction for that eminence being N. 8° E. Near the old church of Rathmichael the direction, on eurite and mica slate, is N. 46° W., evidently on account of the position of that place on the hip of Shankill.

The glaciation of Bray Head presents a peculiarly interesting and somewhat complete study in itself, to which we must return again; we shall now only note that the striations may be seen in a great number of places all about the hill, sometimes on the Cambrian grits and slates, but for the most part on the quartz rock and quartz veins; in different places along the sea side, both below and above the railway (see especially the northern end of the southernmost tunnel); near the small ruined church overlooking the southern end of Bray strand; on the top of the eminence, 653 feet; on the top of that close by to the south, marked on the 6-inch maps, 668 feet, where is some splendid grinding; in several other places along that quartz rock ridge; *in the depression* to the eastward of Ballynamuddagh farm-house; and in several places along the crest of the quartz rock ridge which rises to 793 feet, the highest point (itself scored) of Bray Head. The normal direction of the striations for the hill is N. 31° W., as appears on comparing those cases where there is least deflection arising from local conditions. On the little hill near Windgate, 532 feet, the scoring on quartz rock has the same direction almost exactly; as also in Kilruddery Deer Park, on the east flank of the Little Sugar-loaf. A careful adept will, I believe, be able to recognise on the greatly weather-shattered quartz rock on the very summit of that hill (1120 feet) some remains of the old glaciated surface which have escaped destruction. I believe even that the striation can be seen at one spot, its direction being N. 13° W. On the north-west side of the Little Sugar-loaf, three-eighths of a mile south-

east of Hollybrook House, there is some well-ground quartz rock, the direction of the scoring being N. 24° E., evidently on account of the position of the spot, the current there having been shouldered off by the hill. On some quartz rock, three-eighths of a mile west by north of Kilmacanoge, the striations are N. 25° E.; the stream swept in a curve round the north-west base of the Little Sugar-loaf, into the valley of Kilmacanoge. In that valley we find, on the slope of the Great Sugar-loaf, and about west of its summit, striations running in the direction of the valley, and therefore nearly parallel to those near Kilruddery and on Bray Head. In the same part of the valley, and in the bottom of it, is a considerable extent of well-smoothed quartz rock, the striations on which have been almost, but not quite, obliterated by the weather. The ridge or hill on the north side of the Rocky Valley presents striations on the vein-quartz on its summit, 802 feet, and in different places for the distance of a mile, their general direction being about N. 44° E. The stream was here deflected by the mass of the Great Sugar-loaf; it must have flowed round the north-west flank of that hill, and on over the *col* or saddle (about 900 feet high), near Ballyremon Commons and the "Long Hill." At Greystones, along the west side of the railway, and north of the station, and also on the shore, at the north end of the village, there is some splendid scoring on Cambrian slates and grits, the normal direction for that place being N. 3° W. We find here an example of a second set of striations crossing the normal ones on the same surface, on fine clay slate, both being inclined to the edges of the cleavage. An adept will detect still surviving striations parallel to the normal ones at Greystones, on the quartz veins near the summit of the hill, 725 feet, $1\frac{1}{2}$ mile due west of that village. Passing on southwards, we find that remarkable boss of quartz rock at Kilcool village, presenting striations whose normal direction is N. 6° E. Proceeding thence along the road due south, we find, at the distance of $1\frac{1}{4}$ mile on the left hand, and $1\frac{1}{2}$ mile on the right hand, near Leabeg, on quartz-rock and quartz veins, striations whose normal direction has reached N. 18° E.

We shall now proceed no farther in this direction, and that for three reasons:—We have already transgressed our limits, and gone beyond "the neighbourhood of Dublin;" moreover, there is little friendly quartz rock remaining, to which we might look with some degree of confidence for recorded marks of grinding;* and lastly, and above all, what does remain seems to warn us, if we read its record aright—which is rather doubtful, however—that a step farther may entangle us with the *local* glaciation of the Wicklow mountains. (*See Appendix, at end.*)

* When looking for glacial striation on the quartz rocks and their vein-quartz, it is necessary to guard against being deceived by the (structural) slickensides which occur so frequently among those rocks; but no person whose attention had been once drawn to the matter, could with ordinary care, mistake the one for the other. There are several cases on Bray Head and Shankill of glacially striated slickensides, the two sets of striæ crossing each other, and perfectly distinguishable.

We turn, then, for a moment to the country about fourteen miles west of Dublin. At $2\frac{1}{4}$ miles south-west of Maynooth, in the ditch on the right side of the road, there are to be seen scorings on the limestone, their direction being N. 22° E. In a quarry on the west side of the hill, marked on the Ordnance Maps 312 feet, $2\frac{1}{3}$ miles nearly due south of Maynooth, the limestone has striations N. 19° E. These two examples are $1\frac{1}{3}$ miles apart. In the quarries, half a mile south-west of Clane, scorings can be found in several different places. They vary in direction a good deal, owing to the very uneven surface of the rock; but the normal direction for that place is clearly just about N. 46° E. On Oughterard Hill, near Lyons, at a short distance N. N. E. of the Round Tower, and also three-quarters of a mile north-east of it, the slaty Silurian rock has striations N. 44° E. At the last-mentioned spot there are cross striations north, though not on the same surface with the others. *These* are rather indistinct, and the real nature of them is doubtful. The instances now mentioned in this neighbourhood form an equilateral triangle, whose sides are about $5\frac{1}{2}$ miles in length.

We must now notice some parallel furrowing of a different kind. On reference to the shaded Sheets of the inch Ordnance Maps, containing the environs of Dublin, it will be seen that the country just now referred to between Maynooth, Clane, and Oughterard, has a number of ridges crossing it parallel to each other, and to the rock striations nearest to them. Some of these ridges, *e. g.* the hill above mentioned, 312 feet, $2\frac{1}{2}$ miles south of Maynooth, are chiefly, as it seems, composed of solid rock, and shaped up by drift. Some, *e. g.* the hill at Ardrass, $1\frac{1}{4}$ miles north-east of Straffan, whose summit is marked on the Ordnance Map 308 feet, are entirely composed of drift. The ridge now mentioned is a very well defined and noticeable one, perfectly parallel with the others, blunt at its up-stream end, and tailing off gradually in the opposite direction, distinct as to its composition and structure from an esker, yet somewhat similar in form. It is described by Mr. Du Noyer as "an esker-*like* mound."

Proceeding northwards from Maynooth, we find all the country from about Dunshaughlin to the sea at Portrane and Malahide, and over a width of several miles, in parallel ridges and troughs. In some parts this conformation is very striking; it is apparent even on the unshaded maps, from the number of streams, roads, and fences whose directions have been determined by the shapes of the ground. These ridges are parallel to the rock scorings at Portrane, Donabate, Malahide, Finglas, and Howth, and nearly at right angles to those south of Maynooth and their associated scorings. (*See accompanying map*, Plate I.)

No one can doubt, then, that these ridges and troughs and the rock striations are effects of one and the same cause, since they always correspond with each other as to direction, whatever that direction may be. Now, it has never been shown that moving water can score rocks in parallel lines by sweeping detritus along over them; neither sea waves, nor rivers, nor violent torrents (as Mr. Jamieson has shown in the case of the bursting of the Crinan Canal reservoirs) are able to effect

this. Water currents, then, have not produced the rock scorings, and therefore they have not produced the ridges and troughs. That agency has indeed been at work, and, apparently at the expense of the parallel ridges, which have been sometimes partially, sometimes entirely obliterated thereby, has formed some esker mounds in the district, and, a little south-east of Trim, an esker ridge, five miles long, of most distinctive character, and inclined to the others at an angle of about 20°.

Since the parallel ridges and the rock striations have been produced by the same agent, which must have been the glacial stream, we may avail ourselves of the evidence afforded by them jointly in investigating the course of that stream.

Let us look for a moment beyond our limits, and note that the north-westerly and south-easterly ridging may be traced backwards, most distinctly, from Dublin and Meath into south Cavan, Westmeath, Longford, and south Leitrim at least. It largely affects the outlines of several of the lakes in the district now mentioned. The strike of the ridging makes a continuous curve towards the north as we follow it backwards into Leitrim, so that there its direction is north by west and south by east. Mr. F. J. Foot, of the Geological Survey, has kindly informed me that this parallel conformation of the country is very remarkable near Longford, and that the rock-scorings to be seen four miles east of that town correspond in direction with the ridges and troughs.

We have then evidence of the continuous course of that part of the glacial stream with which we are concerned, by which we see that, having flowed from beyond Longford, across the intervening plain country towards Dublin, it became divided by the resistance of the mountains, the place of division being well defined, and situated about four miles north-east of Maynooth (*see map*); one part turned sharply to the right, and flowed towards the S. S. W. by Clane; the other continued its course straight onwards for a little, and swept round the northern end of the Dublin and Wicklow range of mountains, turning gradually southwards into the wake of the mountains, and running along, for some distance at least, under their lee, nearly parallel to the present coast line. But while sweeping round, it also swept, partly at least, over the end of the range and among the outlying hills thereof. It has left its traces in *roches moutonnées* and ground vein-quartz, at the height of just about 1000 feet on the north side of the Three-Rock Mountain; its marks show that it flowed over the top of Shankill, and over and through the Scalp, into the wide valley of Enniskerry and Powerscourt, over Bray Head, and, as I now firmly believe, over the top of the Little Sugar-loaf (1120 feet). We needed not its traces in the valleys of Kilruddery and Kilmacanoge to assure us that it has swept through those passes. The striations near the Rocky Valley show that it must have passed between the Great Sugar-loaf and Douce into the valley of the Vartry River.

As the glacial stream passed along, it did much more than merely score the rocks; it ground them down into *roches moutonnées*, which in

some places are very striking and characteristic. See, for instance, those on the up-stream side (the north-west) of Rochestown Hill, as also the rounded surface of the north-east shoulder of Dalkey Hill, opposite Ardsunnas Cottage. The rock there, granite, has stood well to be ground, instead of being ripped away in blocks; and the amount of pure abrasion that it has undergone to superinduce its present form of surface has evidently been enormous. The striations have been removed by weathering, except in a few places, where they are still perfectly distinct. Dalkey Island is well worth a visit, if only for the sake of its rounded rocks. The contrast between a down-stream view, in which only the rounded sides of the rock bosses are visible, and an up-stream view, in which their rough lee sides are visible, is exceedingly striking: the scoring has survived only in two places—near the battery, and near the martello tower, on a quartz vein. It is interesting to compare, on that island, the effects of glacial and of marine denudation which are presented in juxtaposition, and to note the difference.

The rounded aspect of the naked summit of Shankill, as seen especially from the west, is very remarkable; the flowing and swelling shapes of the whole of that hill have been evidently rasped out of granite, highly-inclined mica slate, and intractable quartz rock. The humps and prominences on Bray Head, composed of quartz rock, are very decidedly rounded, on the large scale, as well as on the small; this is very visible, to a slightly practised eye, from a distance of a couple of miles, especially if the light be favourable. This rounding, as before, is only on the up-stream side of the prominences. The rounding on a large scale was, doubtless, for the most part, chiefly effected by ripping the rock away in blocks; and it might, therefore, often be very observable, though the rock might have suffered comparatively little from pure grinding.

Some other apparent effects of the glacial stream remain to be noticed; but it will be best now to consider what evidence this district affords as to the nature of that stream. If, then, it were glacial, it must have consisted, not of floating, but of land ice. This conclusion seems *necessitated* (1) by the regular determined flow of the striations, whether regarded on a wide or on a closer view; (2) by the marks of *steady* up-hill grinding on Dalkey Hill and Bray Head,* for instance; though,

* It is interesting to note that the scoring agent has moved straight up the north-west side of Dalkey Hill, the inclination of the ascent being 11½°. Bray Head affords a more striking case still. The striations at the up-stream end of that hill give satisfactory evidence that the scoring agent has moved from the sea level, at the southern end of Bray strand, directly up the side of the hill, to that summit, whose height is 653 feet, in the horizontal distance of exactly half a mile. The inclination of the slope, as a whole, is 14°; but near the top the scoring agent has moved almost straight up a tolerably plane slope, whose length is twenty-seven yards, and inclination 28°. The striations are to be seen on the quartz in several different places on that surface; it is perfectly certain that the movement was upwards, and not downwards. These facts may throw some light on the question, whether the ice of a large glacier could go down into a hollow in the glacier's bed, and up again out of it at the lower end.

of course, a floating mass impinging on a slope could force its foremost end a little way up that slope· (3) by the marks of *down-hill* grinding on the lee side of Howth, as above mentioned; and on that of Killiney Hill, by Mount Eagle House; these, belonging unquestionably to the general glaciation, could not have been caused by any floating mass; (4) by the fact that striations are often to be found at a lower level than the up-stream ground in their vicinity; the scorings near Finglas Bridge, Raheny, and Portrane, and some on Bray Head, are thus situated. The case last mentioned seems to be worthy of special observation. That great band of quartz rock on Bray Head which forms a prominent ridge, one of whose summits is marked on the Ordnance Maps 653 feet, has on its lee-side a depression or slight valley running parallel to it across the main crest of Bray Head; in this depression is situated the farm-house of Ballynamuddagh, and about 256 yards to the E. N. E. of this house we find some smoothed and scored rock. The striations are parallel to the others about the hill, and belong indubitably to the general glaciation, and point directly towards the ridge above mentioned. It is manifest that the scoring agent has flowed over that ridge, and down into the depression on its lee-side, more than eighty feet below, within a distance of a quarter of a mile, which, of course, could not be done by ice floating in the ocean. An inspection of the place will show at once that, if floating ice has ever grated across the glaciated rock now spoken of, it must *necessarily* have moved in a direction nearly at right angles to that of the actual striations on that rock. We may observe that it seems very hard to believe that the naked summit of Shankill and the naked north-east shoulder of Dalkey Hill could have been ground into their present shapes by floating ice. All the striations *hitherto mentioned* are evidently related to one and the same cause; they have been produced by a continuous stream whose sinuosities are clearly explained by the shapes of the ground. If, then, any have been traced by land ice, all must have been so; and that ice has been, in the neighbourhood of Bray at least, over 1120 feet deep.

There are reasons for suspecting that at some period it was much deeper, probably before the time when the stream flowed as its present traces indicate. Whatever may be the real significance thereof, there are well-scratched pebbles in the limestone drift beside Caldbeck Castle, on Kilmashogue Mountain, just above the 1250 feet contour line; and close by Fairy Castle, on the summit of the Two-Rock Mountain, at the height of fully 1760 feet, there are several stones along a boundary fence, some well-rounded and as large as a man's head, of far-transported material, viz., limestone and a white sandstone.

There are some facts which make it scarcely rash to conjecture that at one time the glacial stream may have moved right across the long ridge of the Dublin, Wicklow, and Wexford Mountains, viz., the remarkably rounded outlines of those mountains, even to the summit of Lugnaquilla itself, 3039 feet, notwithstanding the great hollows or "prisons" which have been scooped out of its sides; the parallelism of the transverse valleys to each other, and to the direction of the undis-

turbed current north of Dublin; the straightness and better definition of those valleys on the east side of the mountain range; the fact that their *cols* are often situated to the west of what seems to have been the original position of the watersheds of the passes: the last two peculiarities are precisely what might have been superinduced by a glacial flood of sufficient denuding efficacy, coming from the north-west, *partly dammed-up* by the long mountain barrier, and pouring over the crest thereof down the steeper slope of its lee side. It seems not imprudent to suspect that such may possibly turn out to be the case, when we reflect that the striations across the summit of Shiehallien, in Scotland, 3533 feet above the sea, and across the top of Mansfield Mountain, Vermont, U. S., 4848 feet above the same level, have been attributed to the action of land ice by Agassiz and Professor Dana, respectively. If the glacial stream did ever flow across the Dublin, Wicklow, and Wexford Mountains, it was doubtless before the time when that barrier was able to split the stream at the distance of about eleven miles, near Maynooth.

There are some features, besides those already noticed, which seem to be the result of glacial denudation. The country between Dundrum and Dalkey, and Kingstown and Carrickmines, has some wide ridges and troughs running parallel to the rock scorings, *e. g*, the ridge along whose crest Rochestown Avenue, near Killiney, runs; that of Glenageary, that of Galloping Green and Foxrock, &c. It is clear, from the striations upon the Killiney Hills, and also from the general facts, as shown on the map about that part, that the glacial movement has not been there determined in direction by those ridges and troughs, but that, if there is any relation, they are dependent upon it.

That remarkable gap, the Scalp, cuts across a ridge which is transverse to the direction of the glacial movement. It is almost exactly parallel to the scorings mentioned above, to the east of it. The ice has flowed, as its traces show, through that pass; it would there act, owing to the shape of the ground, with concentrated force. It is the property of actions, like the glacial, working in one direction, that if, owing to some cause or other, they have succeeded in working a slight hollow or channel in a particular place, they will tend to work with increased efficiency in that channel when produced: this fact constantly presents itself to our notice, and the reason of it is obvious. It accounts for the deep grooves and flutings that are sometimes ground (not ploughed) out on well glaciated rocks. The Scalp may be compared to what we may sometimes see, a single groove of this sort; but yet it is not all alone, for 1½ mile to the north of it we have a miniature copy of it in the Dingle (not in the same line), and one-third of a mile to the west of the latter, another little channel or valley, a shallow one; the two last mentioned cut across a low ridge. And again, one mile west of the Scalp, is what we may call the Gap of Ballybetagh, close to Ballybetagh House. These four gaps or channels are all parallel to each other, and, be it observed, their floors are at very different elevations, that of the Dingle being about 380 feet above the sea; that of the Scalp, 502 feet;

and that of Ballybetagh Gap, about 650 feet. It seems as if no explanation can be applied to the Scalp which does not include the cases of the other evidently related gaps. They can all be with equal ease accounted for by glacial action, and under this view their difference of elevation presents no difficulty whatever. The Glen of the Downs might be mentioned in this connexion, and perhaps even certain ravines beyond it, parallel to striations in their vicinity; but the farther we go in that direction the greater is the need of caution, and it will be safer to stop.

We must not omit to notice what some will regard (but, it is respectfully submitted, without sufficient reason) as a disproof of the denuding power of the ice. It has evidently sometimes flowed, as certain modern glaciers do, over the detrital matter beneath it. This is shown by the often magnificent grinding occurring on the upper surfaces of *large* boulders buried in the drift; this grinding is in one direction, and parallel to that on the rock *in situ;* this might have been seen at the Stillorgan and Vartry valley reservoirs, and may yet be seen in an old gravel pit in Foxrock. But if the ice at one time and place flowed over such blocks and their enveloping detritus without disturbing them, it had previously, when perhaps more actively working, brought them thither from elsewhere, so that its power of denudation remains unassailable.

With reference to the transportation of blocks, Mr. Jukes informs us ("Manual," p. 678), that "the Leinster granite sends off boulders in all directions, except the north, but chiefly towards the south-east." Surely this is because the local ice system of the mountains was, to a great extent, interfered with and overborne by the general glacial movement from the north-westward.

APPENDIX.

Although the striation on the summits of Dunran Hill, 1122 (*see map*, D), and Carrick Hill, 1252 feet (C), may not belong to our subject, it is well to mention it. The normal direction of the striations for both hills shows that the grinding has been *from* west by north, *i. e.*, from the mountains. This is quite clear on Dunran Hill, and still more so on Carrick, where the quartz rock ridges have been rounded on one side, precisely like those on Bray Head. The striations on the southwesterly side of Dunran Hill run obliquely *down-hill;* they therefore cannot have been produced by floating ice. Moreover, floating ice could not have ground those summits in the direction of the striations. Did it float across the mountain range, or through the lowest available gap? It must have passed some hundreds of feet above the tops of the two hills. Did it float from the mountains themselves, on a current flowing *steadily* away at right angles to the partly submerged but continuous ridge? This would be, apparently, impossible. The striations were evidently not effected by the proper ice covering of those two hills, as

they have no relation to the slopes. Nothing remains but that they were produced either by the general glacier crossing the mountain range, or by the ice of the local glacial system of the mountains. If the latter alternative be selected, that local system must have been of enormous development; those hills being of the heights mentioned, and both situated at least ten miles from the mountain crest, whose mean elevation is not more than 2100 feet, though it rises much higher in different places.

III.—Notes on the Occurrence of a well-marked Specimen of Knorria in the Lower Carboniferous Limestone Series of Kildare. By J. B. Doyle.

[Read March 9, 1864.]

The fossil plant which I have thought worthy of being submitted to the inspection of the Geological Society was found by a quarryman while engaged in working the Limestone quarry in the townland of Kilreaney, in the barony of Carberry, and county of Kildare. He gave it to his master, Mr. Robinson, of Kilreaney House, who supposed that it was a fish, and as such showed it to his friends as a great curiosity. Mr. Robinson gave it to a gentleman who was engaged in making the survey of Colonel Rich's estate, of which Kilreaney forms a part, and he gave it to me.

I recognised it at once as belonging to a very well-known type, notwithstanding the peculiarity of its shape (to which I take leave to direct your particular attention); and without hesitation I pronounced it to have been found in the Yellow Sandstone of Sir Richard Griffith, as being of such frequent occurrence in that formation.

My friend assured me that I was mistaken, as it was found in Limestone. Having expressed my doubts, he produced a second fossil—the *Cyprina Egertoni*—as having been found in the same quarry by the same man, along with many other smaller shells, "like petrified cockles," as he expressed it, which no doubt were Spirifers, Terebratulæ, Productæ, &c., usually found in this formation.

This led me to inspect the fossil plant with more care, and I soon satisfied myself, both by inspection and by the application of muriatic acid, that its mass was composed of bluish-grey Limestone. I also observed on one side a small piece of crystallized carbonate of lime, and which any person may see by holding the specimen at a proper angle.

Never having met with the like before in my limited sphere of observation, and greatly distrusting my palæontological skill, I showed the fossil to several members of the Society, and also to Sir Richard Griffith, to whom I made known the amount of evidence I had obtained of the locality, and of the circumstances connected with its finding. This evidence I now take leave to submit to the Society.

Fearing that there might be some mistake about the matter, I took

east of Hollybrook House, there is some well-ground quartz rock, the direction of the scoring being N. 24° E., evidently on account of the position of the spot, the current there having been shouldered off by the hill. On some quartz rock, three-eighths of a mile west by north of Kilmacanoge, the striations are N. 25° E.; the stream swept in a curve round the north-west base of the Little Sugar-loaf, into the valley of Kilmacanoge. In that valley we find, on the slope of the Great Sugar-loaf, and about west of its summit, striations running in the direction of the valley, and therefore nearly parallel to those near Kilruddery and on Bray Head. In the same part of the valley, and in the bottom of it, is a considerable extent of well-smoothed quartz rock, the striations on which have been almost, but not quite, obliterated by the weather. The ridge or hill on the north side of the Rocky Valley presents striations on the vein-quartz on its summit, 802 feet, and in different places for the distance of a mile, their general direction being about N. 44° E. The stream was here deflected by the mass of the Great Sugar-loaf; it must have flowed round the north-west flank of that hill, and on over the *col* or saddle (about 900 feet high), near Ballyremon Commons and the "Long Hill." At Greystones, along the west side of the railway, and north of the station, and also on the shore, at the north end of the village, there is some splendid scoring on Cambrian slates and grits, the normal direction for that place being N. 3° W. We find here an example of a second set of striations crossing the normal ones on the same surface, on fine clay slate, both being inclined to the edges of the cleavage. An adept will detect still surviving striations parallel to the normal ones at Greystones, on the quartz veins near the summit of the hill, 725 feet, 1½ mile due west of that village. Passing on southwards, we find that remarkable boss of quartz rock at Kilcool village, presenting striations whose normal direction is N. 6° E. Proceeding thence along the road due south, we find, at the distance of 1¼ mile on the left hand, and 1⅜ mile on the right hand, near Leabeg, on quartz-rock and quartz veins, striations whose normal direction has reached N. 18° E.

We shall now proceed no farther in this direction, and that for three reasons:—We have already transgressed our limits, and gone beyond "the neighbourhood of Dublin;" moreover, there is little friendly quartz rock remaining, to which we might look with some degree of confidence for recorded marks of grinding;* and lastly, and above all, what does remain seems to warn us, if we read its record aright—which is rather doubtful, however—that a step farther may entangle us with the *local* glaciation of the Wicklow mountains. (*See Appendix, at end.*)

* When looking for glacial striation on the quartz rocks and their vein-quartz, it is necessary to guard against being deceived by the (structural) slickensides which occur so frequently among those rocks; but no person whose attention had been once drawn to the matter, could with ordinary care, mistake the one for the other. There are several cases on Bray Head and Shankill of glacially striated slickensides, the two sets of striæ crossing each other, and perfectly distinguishable.

We turn, then, for a moment to the country about fourteen miles west of Dublin. At $2\frac{1}{4}$ miles south-west of Maynooth, in the ditch on the right side of the road, there are to be seen scorings on the limestone, their direction being N. 22° E. In a quarry on the west side of the hill, marked on the Ordnance Maps 312 feet, $2\frac{1}{2}$ miles nearly due south of Maynooth, the limestone has striations N. 19° E. These two examples are $1\frac{1}{2}$ miles apart. In the quarries, half a mile south-west of Clane, scorings can be found in several different places. They vary in direction a good deal, owing to the very uneven surface of the rock; but the normal direction for that place is clearly just about N. 46° E. On Oughterard Hill, near Lyons, at a short distance N. N. E. of the Round Tower, and also three-quarters of a mile north-east of it, the slaty Silurian rock has striations N. 44° E. At the last-mentioned spot there are cross striations north, though not on the same surface with the others. *These* are rather indistinct, and the real nature of them is doubtful. The instances now mentioned in this neighbourhood form an equilateral triangle, whose sides are about $5\frac{1}{2}$ miles in length.

We must now notice some parallel furrowing of a different kind. On reference to the shaded Sheets of the inch Ordnance Maps, containing the environs of Dublin, it will be seen that the country just now referred to between Maynooth, Clane, and Oughterard, has a number of ridges crossing it parallel to each other, and to the rock striations nearest to them. Some of these ridges, *e. g.* the hill above mentioned, 312 feet, $2\frac{1}{2}$ miles south of Maynooth, are chiefly, as it seems, composed of solid rock, and shaped up by drift. Some, *e. g.* the hill at Ardrass, $1\frac{1}{4}$ miles north-east of Straffan, whose summit is marked on the Ordnance Map 308 feet, are entirely composed of drift. The ridge now mentioned is a very well defined and noticeable one, perfectly parallel with the others, blunt at its up-stream end, and tailing off gradually in the opposite direction, distinct as to its composition and structure from an esker, yet somewhat similar in form. It is described by Mr. Du Noyer as "an esker-*like* mound."

Proceeding northwards from Maynooth, we find all the country from about Dunshaughlin to the sea at Portrane and Malahide, and over a width of several miles, in parallel ridges and troughs. In some parts this conformation is very striking; it is apparent even on the unshaded maps, from the number of streams, roads, and fences whose directions have been determined by the shapes of the ground. These ridges are parallel to the rock scorings at Portrane, Donabate, Malahide, Finglas, and Howth, and nearly at right angles to those south of Maynooth and their associated scorings. (*See accompanying map*, Plate I.)

No one can doubt, then, that these ridges and troughs and the rock striations are effects of one and the same cause, since they always correspond with each other as to direction, whatever that direction may be. Now, it has never been shown that moving water can score rocks in parallel lines by sweeping detritus along over them; neither sea waves, nor rivers, nor violent torrents (as Mr. Jamieson has shown in the case of the bursting of the Crinan Canal reservoirs) are able to effect

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* When looking for glacial striation on the quartz rocks and their vein-quartz, it is necessary to guard against being deceived by the (structural) slickensides which occur so frequently among those rocks; but no person whose attention had been once drawn to the matter, could with ordinary care, mistake the one for the other. There are several cases on Bray Head and Shankill of glacially striated slickensides, the two sets of striæ crossing each other, and perfectly distinguishable.

We turn, then, for a moment to the country about fourteen miles west of Dublin. At $2\frac{1}{4}$ miles south-west of Maynooth, in the ditch on the right side of the road, there are to be seen scorings on the limestone, their direction being N. 22° E. In a quarry on the west side of the hill, marked on the Ordnance Maps 312 feet, $2\frac{1}{2}$ miles nearly due south of Maynooth, the limestone has striations N. 19° E. These two examples are $1\frac{1}{2}$ miles apart. In the quarries, half a mile south-west of Clane, scorings can be found in several different places. They vary in direction a good deal, owing to the very uneven surface of the rock; but the normal direction for that place is clearly just about N. 46° E. On Oughterard Hill, near Lyons, at a short distance N. N. E. of the Round Tower, and also three-quarters of a mile north-east of it, the slaty Silurian rock has striations N. 44° E. At the last-mentioned spot there are cross striations north, though not on the same surface with the others. *These* are rather indistinct, and the real nature of them is doubtful. The instances now mentioned in this neighbourhood form an equilateral triangle, whose sides are about $5\frac{1}{2}$ miles in length.

We must now notice some parallel furrowing of a different kind. On reference to the shaded Sheets of the inch Ordnance Maps, containing the environs of Dublin, it will be seen that the country just now referred to between Maynooth, Clane, and Oughterard, has a number of ridges crossing it parallel to each other, and to the rock striations nearest to them. Some of these ridges, *e. g.* the hill above mentioned, 312 feet, $2\frac{1}{2}$ miles south of Maynooth, are chiefly, as it seems, composed of solid rock, and shaped up by drift. Some, *e. g.* the hill at Ardrass, $1\frac{1}{4}$ miles north-east of Straffan, whose summit is marked on the Ordnance Map 308 feet, are entirely composed of drift. The ridge now mentioned is a very well defined and noticeable one, perfectly parallel with the others, blunt at its up-stream end, and tailing off gradually in the opposite direction, distinct as to its composition and structure from an esker, yet somewhat similar in form. It is described by Mr. Du Noyer as "an esker-*like* mound."

Proceeding northwards from Maynooth, we find all the country from about Dunshaughlin to the sea at Portrane and Malahide, and over a width of several miles, in parallel ridges and troughs. In some parts this conformation is very striking; it is apparent even on the unshaded maps, from the number of streams, roads, and fences whose directions have been determined by the shapes of the ground. These ridges are parallel to the rock scorings at Portrane, Donabate, Malahide, Finglas, and Howth, and nearly at right angles to those south of Maynooth and their associated scorings. (*See accompanying map*, Plate I.)

No one can doubt, then, that these ridges and troughs and the rock striations are effects of one and the same cause, since they always correspond with each other as to direction, whatever that direction may be. Now, it has never been shown that moving water can score rocks in parallel lines by sweeping detritus along over them; neither sea waves, nor rivers, nor violent torrents (as Mr. Jamieson has shown in the case of the bursting of the Crinan Canal reservoirs) are able to effect

again a second series of marks, which bear about north-east and south-west.

Most of the groovings have coarse and jagged edges, and appear as if the rock was subjected to the sharp tearing and planing of some harder substance rubbed against it; in other cases the signs of rough treatment are no longer visible, and the surface appears rather as if it were slightly rippled than cut and indented by violent action.

What cause, then, would be likely to produce such stupendous effects as those which we have been just considering? Slipping mud will hardly account for it.

We must, therefore, once more have recourse to the old ice theory. But the question now arises, in what form did the ice work? Was it in the form of a glacier, or of an iceberg?

The shape and position of the side of the hill makes the idea that the polishing and marking were caused by an iceberg seem not improbable. An iceberg bobbing up and down, as we often see a half-stranded cork on the shore, *might* apparently produce these effects; but, as was suggested to me by Mr. Close, if an iceberg were partially stranded, it would float about, moving on some great fixed centre; and thus all the markings and groovings would be huge uneven curves, or rough arcs of circles.

Further, if it were an iceberg, it is highly improbable that it is from the land side that it would approach, the polished rock being on the inland side of the hill.

What remains, then, for us to assume is, that the centre of Ireland was a great snow plain of considerably greater elevation above the sea than at present, and that numerous glaciers descended from it in various directions. One of these, going towards the west, encounters a small elevation in its course, is raised slightly up by it, presses with all its irresistible force against it—tears, grooves, marks, and polishes the opposing surface—and when it attains the top of the hill, goes along on its way over the snow, no longer touching or interfering with the rocks beneath till it is finally lost in the ocean.

So much, then, for the principal striæ, or those which run east and west; but there remain still another set of them, running north-east and south-west. These are very much inferior in depth and boldness to the others, and appear to be due to a subsequent action, namely, *the action of the Drift.* The large quantities of gravel, mixed with aluminous clay, differing from the surface earth, and the numerous boulders scattered about in all directions, give their undoubted testimony to the occurrence of drift action in this neighbourhood.

The direction of these marks, and the presence of the gravel to produce them, point both to the same conclusion, viz. that the minor striæ were caused by the drift; while, on the other hand, as was before stated, the greater striations, grooves, and polish are due to the direct action of ice, most probably in the form of a glacier.

SKETCH SECTION ACROSS THE CENTRAL GRANITE OF THE COUNTY OF DONEGAL.

1. Bluestack, 2219 feet.
2. Croagh Connelagh, 1724 feet.
3. Col.
4. Barnes Mountain, 1275 feet.
5–6. Valley of the Eany.
7. Col.

VII.—Notes on the Physical Features of the County of Donegal. By W. Harte, C. E.

[Read June 9, 1864.]

The mineralogy of the county of Donegal having already received so much consideration in the proceedings of this, the London Geological Society, and the British Association, it may be interesting to lay before you the result of some investigations of mine into its physical features, which are not alone striking from the boldness of their scenery, but from the fact that they have received, as I think I can show, much of their present forms from the last great epoch in the history of our planet, that of the glacial period.

The county is intersected by bays, estuaries, and river courses, flanked by the higher mountain ranges and hills; and so much is it thus cut up, that no portion of it is twelve miles from the reach of the tide.

The peat and vegetable soils rest upon the drift, and these again directly upon the Primary, Metamorphic, and Palæozoic rocks. The latter consist almost exclusively of the Carboniferous system, and are only found fringing the Bay of Donegal and near Pettigo, Muff, and Carrowkeel.

The higher and most central mountain range runs from the southern end of the county to the north, in a general direction almost due north. It there is met by the range which runs along the north end of the county to the north of east, including the mountains of Errigle (2462 feet high), Dooish, Muckish, Slieve Snaght, &c., and parallel to the direction of, and through the district where the trap rocks attain their greatest development. The main igneous feature of the first range is the granite, while that of the second is the syenite.

To the east and west of this dividing granite range, or main axis of elevation, run several valleys; those of the Rivers Eske, Eany, Glenties, Gweebarra, and Gweedore on the west; and those of the Mourne, Finn, Swilly, Lennan, &c., to the east and north.

Towards the southern end of this range, near the head of the Bay of Donegal, we have a group of mountains, which have been termed the "Central Granite Patch," which I shall describe more particularly, as it is a district of much interest. Through this group of mountains runs the present road from Sligo to Londonderry, through what is called the "Gap of Barnesmore," which is the only gap in the range.

To the south of the road lies the steep escarpment of Barnesmore Mountain, which rises to a height of 1491 feet; and to it immediately succeeds the range of crystalline schists and gneiss, which, including Breecy Mountain, sweep round the south coast of the Bay of Donegal, and terminate at Lough Erne, near Ballyshannon.

To the north of the road in the "Gap," rises the rounded form of Croaghconnellagh (or Townawilly) Mountain, 1724 feet high. The valley of the Gap runs round the north east end of this mountain, and

then west again, parallel to its first course, dividing Croagh Connellagh from the next ridge, Croaghanirwore, 1972 feet high, and it is there closed by the col of greenstone, &c., which separates it from the Eske valley. To this valley of the Barnes River, as possessing some interest, I shall have to refer again. To this latter ridge succeeds another valley; and on the other side the last of the granite rises with a steep escarpment over Lough Belshade, facing the south. This mountain is called Croaghgorm, or the Blue Stack Mountain, and is by far the boldest and most rugged of the granite mountains of Donegal, rising to a height of 2219 feet. Lough Belshade lies in the gneiss at the foot of it; and the north side of this mountain and the south side of Barnesmore both have long slopes, exhibiting thus the structure of "crag and tail."

Then succeeds the northern range of Primary and Metamorphic rocks, schists, and quartz, which flank the northern side of the bay, ending in the splendid cliffs of Slieve League, 1964 feet high, and form the western headland of the bay.

Radiating from this central granite to the north-east, and south-east, are the valleys of the Rivers Finn and Mourne, and of the Inver and Eske Rivers to the west and south-west.

Within this basin of the Primary and Metamorphic rocks surrounding the Bay of Donegal, and lying all round between them and the sea (except towards the north-western extremity of the bay), the country consists of the Old Red Sandstone and Carboniferous formations.

This Barnesmore granite, as I shall call it (while, however, it is to be understood as a name for that of the whole central granite), is a very hard compact granite, of a pink-grey colour, and contains crystals of a deeper red orthose scattered through it; and so uniform are its characters, and distinct from the other granites of the county, that there can be no difficulty in recognising it whenever it is met with.

Passing from Blue Stack along the col which divides the valleys of the Eske and Inver Rivers, we come almost at once upon the Old Red Conglomerate. A thin chocolate-coloured band with white quartz pebbles, of equally striking appearance with the Barnesmore rock, and constantly accompanying it, they form unerring guides to the western drift, whether found in the shape of large blocks, or of fine gravel.

We next come upon the Lower Limestone and coarse conglomerate of the Yellow Sandstone (a very different one from the last, being all quartz pebbles and sand), and which is succeeded by the finer beds of sandstone, in which the Mountcharles quarries lie. This ridge divides the valleys of the Eske and Eany Rivers and estuaries; and along the course of both, running out to the sea from the high granite range, the lower soft sandstone and arenaceous limestone rocks are cut up by valleys bearing south-west, and these are again intersected by other valleys obliquely crossing them, forming hills varying from about 50 to 500 feet high.

Far in all directions along the courses of the river valleys of the Eany, Eske, Finn, and Mourne, radiating from this centre into the county of Tyrone, and out to sea, may the drift from these mountains be traced (the conglomerate, so far as I know, only appearing to the

west). It lies on all the hill-tops, and forms much of the subsoil of the valleys. It is characterized, as usual, by the large "erratics," and the smaller boulders and gravel. The former for the most part are rather wanting in angularity, having been subjected to the rubbing action of the latter when the sea was falling; nor are many of these erratics very large (though they are to be met with up to forty tons in weight); for the granite of Donegal, as so well described by our late President, Professor Haughton, "possesses a stratified structure in beds which are nearly vertical;" and "in addition to this stratified, or cleaved structure, it is traversed by many joints, which run nearly at right angles to the directions of the planes of the cleavage structure,"—characters more applicable to the Barnesmore granite than perhaps to any other in the county, as some of the soundest blocks, apparently, cleave only to a size of eight inches cubic when being dressed, while it accounts for the comparatively small size of the boulders and erratics generally, and which it is well to keep in mind when estimating the effect of a glacial climate, and the facility which these rocks afford for excessive denudation. The erratics, however, from Blue Stack Mountain, which I have described as being of more massive structure, were chiefly carried down the Finn Valley, and attain to very large dimensions.

The Yellow Sandstone ridge upon which Mountcharles stands is the highest of the hills within the basin of those Primary rocks, and consists at Lough Eske of the coarse-grained conglomerate of sand and rounded quartz pebbles only.* This ridge terminates abruptly in a bluff at the shore of Lough Eske, near the col which separates the valleys of the Eske and Inver; and on the terraces of its face, formed by the out-cropping of the lower limestone beds, the granite boulders have been dropped. It there rises to a height of 1275 feet, upon which rest blocks of the granite from Blue Stack; and as it rose from the water at an early part of the glacial period, it subdivided the currents of larger ice, which then first scooped out these valleys of the Eske and Eany. Within these valleys, as I have said, are a number of smaller hills. Their shape is of an ovate form, except where modified by local circumstances, the bluff end, or higher slope, being turned towards the mountain range, and the longer slope towards the sea. The direction of the major axes of these hills converges, and exactly follows the course which the ice, when breaking up, would have to take in falling away from the inner sides of the basin of the mountain range, towards the sea; and with singular accuracy do we find the drift deposited upon these hills and in those minor valleys to consist of the Primary rocks, whether granite, schist, or gneiss, to which the longer axis of each hill points: thus we have near Donegal the granite and conglomerate on those pointing to Barnesmore, while

* It may be interesting to those who insist upon a geological distribution of certain plants to say, *en passant*, that in the crevices of these huge rocks, dislocated by the action of ice, I found the *Hymenophyllum Tunbridgense* in flourishing growth in March last at the height of 1275 feet, where not four feet from its habitat hardly any vegetation exists.

we meet chiefly garnetiferous schists of Finmore at Laghey, and the gneiss of the Aught Mountain at Ballintra, &c.

Those hills of the Yellow Sandstone and Lower Limestone are smoothed and dressed by the action of the sea, which washed down the smaller drift towards their bases, and mixed it with the local lime and sandstones, and doubtless this was caused by the floating out to sea of the smaller ice, an ample store of which would be provided when the land rose so as to form a large fiord where Lough Eske now lies.

The rocks forming these hills dip at an angle of about 20° from the granite towards the sea, to which cause I attribute the absence of polished and striated surfaces, as the rubbing action of the ice would be against the ends of the beds, and not against their upper surfaces.

I observed that I would allude again to the "Gap of Barnesmore." It rises at its east end against the col which separates that valley from those of the Finn and Mourne; and being a branch of the Eske valley, it turns, as I described, to the north, and then back, westward, round Croaghconnellagh, giving to the latter its hemispherical appearance. The valley is very narrow at the level of the road, being only about 150 or 200 feet wide at the base of the mountains, which, as I said, on the south, or Barnesmore side, form a steep escarpment, while on the north side it slopes at about $\frac{1}{2}$ to 1; altogether, the steep valley may be said to be about four miles long.

Both the road and river in running through the Gap cut through ridges of *debris*, in fact *moraines*, the terminal ones of an ancient glacier (marking successive stages of its retreat, very probably), and which at one time filled this valley, and left a large deposit upon the col between the head of the Gap and the valley to the east. It is hard, in granite so fissile and so easily weathered, to find marks of erosion, but these are not altogether wanting; grooving and terracing can be detected at considerable heights by close observation. In the same way the other valleys which occur throughout the range to the north of this must have been filled with glaciers also.

So much for the disposal of the ice on the interior of the basin of the Bay of Donegal. On the outside of this range, and along the central dividing ridge, the ice must take a course the reverse of a convergent one, and diverge, breaking up into sections determined by the directions of the spurs of the main range, and it accordingly did so.

That lying to the north of this central range and west of the northern chain went to the north-westward, while that upon the high mountains near Fintown descended, and, joining that from the valley north of Blue Stack, scooped out the valley of the Finn, which became ultimately joined by the ice from the southern end of the range, after passing along the course of the Mourne, and formed the valley of the Foyle. To the north of this "central granite" the ice simply broke away to either side, east and west, forming the long straight valleys of the Gweebarra, Glenveigh, &c.

The original disturbing igneous force which upheaved those mountains operated with its greatest intensity upon the central granite,

giving the radial structure to it, and throwing out spurs as it passed northward, which, as I have said, fixed the subsequent course of the ice; for I do not find the rocks of any of its divisions to have crossed the intervening ridges, but simply followed the course of the retreating ocean.

As I have described, between the granite range and the coast of the Bay of Donegal, the country is what may be called a rapidly undulating one, and these undulations come down to the edge of the shore. Let us now go a little further, and we find by the naval charts surveyed by Captain Bedford, R. N., in 1853 (and they afford ample details), that no such undulations exist in the sea bed off this coast. Those hills of from 50 feet to 500 feet high which I have been describing, and whose seaward ends are abraded by the action of the sea, cease at once at the shore, and in their place succeeds an almost level sea bed; and if we refer to the more extended surveys, we find the same plateau or gentle gradient extending to the edge of the 98-fathom contour, or so-called "Irish bank," nearly 60 miles off the coast, unbroken by a single sounding, that if the sea bed were dry would prominently attract the eye as an inequality, showing no sign of glacial disturbance, and which the slight elevation of seven feet per mile would be sufficient to bring above the level of the sea. (See Plate II.)

I think it is a fair inference from this that, though the land rose (where we now find the erratics) at least 1300 feet above the level of the sea (and very likely went a little further), the glacial action was then at its close.

I may now call attention to another feature of some importance, that of the bogs of the county. They lie on flats, at all heights, from the mountain tops to the level of the sea. In them the remains of ancient forests are embedded, at least from the 500-feet contour down. Above this level and up to the 1200-feet contour, I have found only a few straggling remains of dwarf trees in the peat—the roots standing as they grew in the peat and on the surface of the drift and Pleistocene gravel. Many of those forests are submerged at high water, and at a few feet higher level than high water are several others. Much stress has been laid upon these submerged bogs, as showing, it has been supposed, oscillations in the relative levels of the land and sea since the glacial period. I have examined numbers of these submerged bogs; and though I am still engaged in doing so, up to this I have not found any satisfactory evidence to show that this submergence is due to alteration of the level of the land since the drift has been deposited. All the cases I have seen are quite consistent with either of two views—one, that these submerged bogs and forests in some cases were detached, probably by fresh water, from those at higher levels, and deposited below or at the edge of low water. The other view is, that they were originally growing in lagoons, and that the erosion of the coast eventually brought them within the action of the sea. In nearly all the cases I have seen, the latter seems the most usual; and while we cannot say anything of those forests that may be under the sea (and they probably are very exten-

sive), we can say, so far as my experience goes, that those just above high water show indications of never having been submerged; and this could not be if those oscillations of level had occurred, which are described to have taken place in some geological works.

One case forcibly illustrating this view I may state more in detail. While staying at Dawross, a bay about six miles north of the village of Ardara, a friend of mine mentioned his surprise at having lately become possessor of some excellent bog upon the beach, over which he had hauled up his boats for years, quite unconscious of the existence of any forest being several feet under it. I examined the place, and there found the roots of trees (oak and fir) lying in peat, the bottom of which is from twelve to fourteen feet below the level of high water; and on investigating the whole circumstances of the case, I found, beyond all manner of doubt, the following to be the true explanation of what would *primâ facie* be set down as the results of depression of the coast, and subsequent upheaval.

The whole coast is of mica slate, impregnated with andalusite, and the rocks are very easily broken up, being traversed by very close planes of cleavage, so that the work of encroachment by the sea goes on with the greatest rapidity at times. There are numerous small islands out to sea and across the bay, three of which were connected in the memory of those living there, forming a little promontory—that is, there was between, in front, and behind them, and joining them with the shore, a beach composed of large and small stones (the *debris* of the same rocks) mixed with sand, and over that four to six feet of "blown sand," upon which was grass and bent. It was under this beach that the bog lay. Outside these little islands are other rocky islands, forming a breakwater.

Originally these trees were growing in a lagoon, in which these islands formed projecting rocks. When the sea made its present passage through the outside barrier (now island), which it would do as it has just done suddenly, it swept in the beach lying outside through the breaches it had made, and buried the trees and bog inside under the shingle and the *debris* of the rocks. Over this came the "blown sand," and on it grew the bent, the outside rocks through which it forced its way acting as a breakwater to this new formation. The bog and trees lay thus buried, probably for ages; but now, within the last two years, the breakwater being too much eroded to form a sufficient protection any longer, the sea is now undoing—indeed, has almost completely undone—its own former work, and is breaking up the bog and the islands (lately a promontory), and in a very short time all will be away, with much of the inner shore.

Thus we have a bog buried, probably a great length of time, under a beach, according to popular ideas, rising into view again, without the slightest room for doubt, on a close examination, that, so far as evidence goes, it never changed a foot in level since the time when it stood, as unquestionably it did stand not long ago, geologically speaking, about two miles inland, and very probably was protected, when these trees

were growing, by some of those greenstone dykes which run parallel to the coast line.

I do not wish to be understood as taking upon myself to deny a secular depression of the coast; I only want to show how one of the best cases instanced as leading to such a view tells, on close investigation, as much for the contrary opinion.

As I pointed out, at the close of the glacial epoch the land had risen to about its present level; and there is no reason to say that that upheaval may not have been carried a very little further, with a gradient of less than seven feet per mile, which would have exposed the present sea bed, and left a margin of sixty miles at least of land outside our present west coast line. This would have exercised an influence most favourable to the growth of forests, even at the high levels inland, and to the development of a series of lagoons, upon the inner edge of which we now look, after they have been encroached upon by the sea, while they may be possibly descending again; but, if so, it is for the first time; and such depression of level has not before occurred within the period of the extinct forests, and acts only as an auxiliary to the undoubted erosion of the coast, which has accumulated at the foot of the high lands the immense sand-dunes we see now on the exposed parts of the shore.

I shall not enlarge here upon the subject of the temperature of the glacial epoch. I may state, however, the following:—The highest point of Blue Stack is now 2780 feet below the snow line. If to this we add at least 1300 feet, which it was lower previous to the upheaval at the close of the glacial period, we shall have its summit then 4080 feet below the present snow line! Glacial denudation alone, without a lower snow line, cannot possibly account for all this; and the facts seem to me to be strongly opposed to those who, on the one hand, would dispose by change of temperature alone of the glacial question, irrespective of any upheavals or depressions of the land, or to those who, on the other hand, hold only to the idea of the much greater elevation of the land then,—while they appear to me to harmonize well with the middle view of a combination of both theories, viz.:—greater height of land, and a lower snow line, at the earlier parts of the glacial epoch. This, I know, is a *vexata quæstio;* but my object in laying these Notes before you has not been to theorize upon so important a question, but in the hope that, though of more local perhaps than general interest, they may afford some useful information upon the Post-tertiary geology of Ireland.

VIII.—Geological Notes on some of the Islands of the West of Scotland. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin.

[Read December 14, 1864.]

The following brief notes, mineralogical and geological, made during a yachting cruise in the West of Scotland, on board Mr. Graves' yacht, "Ierne," in the summer of 1864, may possibly be interesting to the Royal Geological Society of Ireland, in consequence of the intimate relation between that part of Scotland and the North of Ireland:—

1. *Crystalline White Limestone of Iona.*—On the 17th of July we visited the metamorphic white Limestone of Iona, described by Jamieson and others. It bears N. 15° E. by compass, and dips 80° E., and is from 40 ft. to 50 ft. in thickness. It is pure white, and has a remarkable flaky appearance, which is fully explained by its mineralogical composition.

On being analyzed, it was found to consist of—

1. Dolomite,	70·7
2. Silicate,	29·3
	100·0

The Dolomite was found to have the composition—

1. Carbonate of Lime,	82·5
2. Carbonate of Magnesia,	17·5
	100·0

The Silicate gave, on analysis—

		Atoms.	
Silica,	59·00	1·311	3
Alumina,	0·64		
Lime,	12·44	0·444	4
Magnesia,	27·01	1·350	
	99·09		

This corresponds to the formula

$$4\,(MgO, CaO),\ 3\,SiO_3,$$

and the mineral must be regarded as a variety of Tremolite.

At the time of our visit it was nearly high water, and we were therefore unable to examine the portion of the Limestone which is exposed at low water, and which is said to pass into Verde Antique, of which, indeed, we found several rolled pebbles on the strand.

2. *Labradoritic Syenite of Loch Scavig, in Skye.*—We visited the remarkable mountains that surround this wild Loch on the 3rd August, and brought away with us very good specimens of the Syenite of which they are composed.

The mass of the rock is a medium-grained Syenite, composed of Augite and Labradorite, and was particularly interesting to me, because I had failed to find this rock in Donegal, although there are specimens collected by the late Mr. Townsend, C. E., probably from Donegal, in the Geological Museum of Trinity College.

Beds of metamorphic rocks, in which Labradorite forms an essential constituent, are well known to form an important part of the Laurentian system in Canada, and I was therefore glad to have an opportunity of examining a similar rock *in situ* in Scotland.

The Syenite is bedded, and evidently metamorphic, and is penetrated frequently by dykes of similar Syenite, sometimes finer, sometimes coarser in the grain. In the coarsely crystallized masses, the Labradorite and Augite acquire large dimensions, and are associated with a considerable quantity of Ilmenite, such as is found in the Oligoclasic Syenite of Horn Head, in Donegal.

The following analyses show the composition of this Syenite, and of its two constituent minerals:—

Loch Scavig Syenite.

Silica,	48·12
Alumina,	23·40
Protoxide of Iron,	3·28
Protoxide of Manganese,	1·68
Lime,	15·43
Magnesia,	5·31
Soda,	1·86
Potash,	0·03
Water,	0·48
	99·59

Feldspar of Scavig Syenite.

	Percentage.	Oxygen.	Atoms.	
Silica,	53·60	27·829	9·276	2
Alumina,	29·88	13·964	4·655	1
Protoxide of Iron,	0·20	0·044		
Lime,	11·02	3·132		
Magnesia,	0·07	0·027	4·599	1
Soda,	4·92	1·261		
Potash,	0·80	0·135		
Water,	0·48			
	100·97	46·392		

This analysis gives us very accurately the formula of Labradorite, of which it is an excellent example.

An examination of the cleavage planes of the Hornblendic constituent of the Syenite proves that this mineral is Augite, and not Hornblende; for its cleavage planes are nearly at right angles to each other,

and this crystallographical proof is further confirmed by the chemical analysis, which gave the following results:—

Hornblende of Scavig Syenite.

	Percentage.	Oxygen.	Atoms.	
Silica,	50·80	26·376	9·259	2
Alumina,	8·00	1·402		
Protoxide of Iron,	9·61	2·182	14·040	3
Lime,	19·35	5·501		
Magnesia,	15·06	6·018		
Soda,	0·44	0·112		
Potash,	0·22	0·036		
Protoxide of Manganese,	1·08	0·241		
Water,	0·60			
	100·16	41·818		

This result corresponds with the well-known formula for Pyroxene,

$$3RO, 2SiO_3.$$

3. *Granite of Ross of Mull.*—On the 17th July we visited the celebrated Granite quarry of the Ross of Mull, from which it was proposed to obtain the monolith in honour of the late Prince Consort. The Granite is coarse, with Quartz abundant, and only one Feldspar, viz., a pink Orthoclase, with a little black Mica.

Its analysis shows that it differs much from the Granite of Strontian,* two analyses of which were published by me in the "Quarterly Journal of the Geological Society of London," in Part IV. of my "Experimental Researches on the Granites of Ireland."

Granite of Ross of Mull.

	Percentage.
Silica,	74·48
Alumina,	16·20
Peroxide of Iron,	0·20
Lime,	0·13
Magnesia,	0·27
Soda,	3·78
Potash,	4·56
Water,	0·60
	100·22

4. *Gryphæa Beds of Loch Aline.*—On the 15th of July we visited these beds, and found them to consist of decomposing dark beds of shaly Limestone, at the sea level, abounding in *Gryphæa incurva, Pecten quinquecostatus*, and a species of *Lima;* above the shaly Limestone lie thick

* One of those Granites is published, on the authority of Sir R. Murchison, as from Tobermory, but I believe it was originally a specimen from Strontian, and was brought to Tobermory as a building stone.

beds of White Sandstone, without fossils; and this Sandstone is again covered by thick masses of tabular Basalt.

5. *Tertiary Leaf Beds of Ardtun Head.*—On the 18th of July we rowed across from Iona Bay to Ardtun Head, and were shown the Tertiary leaf beds by Mr. Campbell, who kindly provided us with blasting powder and jumpers, by means of which we succeeded in obtaining some excellent specimens of *Platanus Hebridicus.* This was the only fossil leaf we found, and it was obtained in the bed of Shale that underlies the bed of Conglomerate formed of chalk flints and chalk pebbles.

6. *Lias Beds at Tobermory.*—On the 20th July examined the lias Shale of this locality, in the roadway leading to the Baptist Chapel. I found it to contain Liassic Belemnites, Ammonites, and Terebratulæ. The Shale beds are covered by massive Trap. The Red Sandstone, on which some of the houses in Tobermory are built, appears to lie under this Shale, but I was unable to determine whether it is Old or New Red Sandstone.

7. *Lias Beds of Pabba.*—We visited the island of Pabba on the 1st August, and brought away, by diligent quarrying, a good collection of fossils. These were kindly examined and named for me by Mr. Baily, Palæontologist of the Geological Survey of Ireland, who possesses special knowledge of these fossils, from the fact of his having assisted Professor Forbes in the determination of the Oolitic fossils found by him at Loch Staffin, in Skye. The following were the principal fossils found by us:—

1. *Serpula vertebralis* (Oxford clay and Cornbrash).
2. *Rhynchonella lacunosa* (*vide* Davidson, Pal. Soc., Pl. xvi. Fig. 15, from Lias, Skye).
3. *Lima læviuscula* (closely allied to *L. gigantea*, Lias).
4. *Pecten fibrosa?* (like *P. æquivalvis* of Lias).
5. *Gryphæa dilatata.*
6. *Pinna mitis?* (Phil., Pl. v., Fig. 7. Oxford clay species, found at Loch Staffin; *vide* Forbes on the Oolites of Skye, "Proc. Geol. Soc.," vol. vii., p. 110.)

8. *Oolite Beds of Mull.*—On the 5th August, we landed at a new locality for fossils, on the east side of Mull, pointed out to us by Mr. Campbell, of Aros, Tobermory. We found Shale beds at the sea level, converted into flinty Hornstone, of a greenish colour, by enormous masses of amorphous Trap that covered them; and it was with much difficulty we brought away the few fossils we quarried out, as there was a heavy sea running on the shelving rocks, and our gig was in some danger of being stove in.

Mr. Baily has named the following:—

1. *Pecten, sp.* (with large ribs).
2. *Belemnites Oweni?* (Oxford clay species, from Skye).

IX.—On a Recent Erratic Block. By F. J. Foot, Geological Survey of Ireland.

[Read November 9, 1864.]

The glacial question is one of so much interest to geologists, that it is important to record every well-ascertained fact connected with the mechanical action of ice.

At the present day, in the British Isles we have no glaciers, and the sea seldom freezes around our temperate shores. Glacial action, once so powerful, and so widely extended, is almost exclusively confined to the degradation of cliffs, large fragments of rock being detached, and caused to fall in winter by the freezing, and consequent expansion of water which finds its way into the open joints and crevices in the rock. Even limited to this, ice is no mean agent in altering the configuration of a country during the lapse of ages, and in supplying detritus, to be strewn eventually over the bed of the sea, and, in time to come, perhaps to be raised above its surface in the form of new land.

But I have had lately brought to my notice an instance showing that ice can occasionally do more than this; that, instead of being solely a stationary engine, it may also act as a locomotive one; and that, under favourable conditions, large blocks may still be transported by it.

At the northern extremity of Lough Ree, on the Shannon, on the Longford side, the water of the lake is very shallow for a considerable distance from the shore—too shallow, indeed, in most places to float a small boat. Here and there, crags of limestone extend for some distance along the shore, but the bed of the lake itself is composed of shingle and large and small fragments of limestone.

On the shore at Rathcline, the residence of St. George Johnston, Esq., a little shingly promontory, scantily covered with grass, juts out into the shallow water of the lake; and at a distance of twenty or thirty yards from its point may be seen, resting against each other, two dark coloured, rugged, waterworn blocks of limestone.

When I visited the spot, on the 17th of October, the depth of the water appeared to be about two feet. The dimensions of the mass, as roughly estimated, are about seven feet in length, three feet in breadth, and three feet in height from the water line. The weight is probably about two tons. These blocks are *recent erratics*.

Before the great frost, which commenced in January, 1855, memorable to naturalists and sportsmen as having been so destructive to our birds, there stood out in the lake a conspicuous rock, or boulder of limestone, fifty yards west of the present site of these two blocks.

Mr. Johnston, to whom I am indebted for information on the subject, tells me that, when visiting Quaker's Island—a valuable island belonging to him, about four miles to the southward—he always steered by that rock, so that it was well known to him and his boatman. At high water, after floods, it was sometimes covered, and was then dangerous to boats. When the frost commenced, the water of the lake was very low, the

depth being three feet or so at the rock, which protruded about 2½ feet above the water.

The frost lasted six weeks; at the end of which time a thaw set in, with a strong south-west wind. The ice broke up, and immense blocks of it were piled up on the Rathcline shore; the breaking up and piling of these huge masses of ice was accompanied by a roaring sound, which could be heard at a considerable distance.

As well as I can ascertain, while the storm increased, the wind went more to the west. During the thaw the water of the lake rose about two feet by means of the fresh flood-water and the force of the wind. Then this block of limestone was actually floated up from the bottom by the great mass of ice into which it was frozen, and drifted in before the wind till it grounded in shallow water, and smashed in two in its present position off the point of Rathcline. The first time after the thaw that Mr. Johnston went out boating, he and his man were struck by the altered position of the rock, and on coming up to it they observed that it was broken in two and turned upside down.

Mr. Johnston, in writing to me on the subject, says—"My opinion at the time was, that the stone—a very rough and jagged one—had gradually become entirely frozen up and united with the ice; that as the Shannon rose the stone was raised up with it, and in the ice, which was then driven into the shallow water and turned up by the storm. . . . . In its original position the stone lay in the way of a small boat hugging the shore, when the wind blew from the east, and it was desirable to keep close to the shore; this caused me, the very first time I was on the Shannon after the frost, to remark the change of position in the stone, and then on coming nearer to it we thought it had been turned upside down."

Singularly enough, a little more than half a mile north-east of the blocks on the hill between the lake and Rathcline House, there is also a good example of an erratic of the glacial period; it is a remarkable boulder, perhaps a ton in weight, very hard and siliceous, and bright red; in fact, it is jasper. Now, jasper is seldom found *in situ* except in the form of pebbles in the Old Red Conglomerate, and I have often wondered whence they were derived.

North-east of Rathcline, in the county of Roscommon, the long ridge-like hill of Slievebawn rises from the generally level limestone plain to a height of 850 feet above the sea, exposing the sandstones and conglomerate of the Old Red and the subjacent grits and shales of the Silurian. In the latter rocks, and near the summit of the hill there occurs, apparently in the form of a large vein, a mass of hard, blood-red, very siliceous rock, which I can only designate as "*jasper rock.*" It is a great, rugged, amorphous mass, homogeneous in texture, and presenting to the view no lines of stratification. No actual junction is seen between it and the adjacent Silurian grits and shales, but it is most probably a large vein or pocket.

Being well acquainted with this rock, I at once recognised the Rathcline boulder as a fragment of it, and there can be no doubt that it is an

erratic from Slievebawn. The distance from the boulder to the parent rock is just six miles, and the direction N. 30 W.

Thus we have, side by side, these two erratics: the one of jasper, carried by an iceberg a distance of six miles countless ages ago, in the far off glacial period; the other of limestone, transported fifty yards by a mass of fresh water ice, ten years ago.

APPENDIX.

"*Longford, November* 8, 1864.

"My Dear Sir—When out surveying to-day, I came across a surface of limestone, about twelve feet by fifteen, or so, laid bare of soil, and most beautifully scored by (glacial?) striæ, perfectly parallel, some of them nearly an inch deep, and bearing N. 25 W. nearly. Now, if any one take a glance at the inch maps of this district (the plain ones) they will at once be struck by the wonderfully parallel conformation of the country with respect to streams, low hills, and long narrow bogs. The direction of this parallel conformation is generally about from N. 20 to N. 30 W., coinciding with that of (glacial) striæ above-mentioned; also the direction in which the jasper boulder, mentioned in my paper, is carried, is identical, or nearly so, with it. Would you be kind enough to mention this fact when my paper is read, as I think it is very interesting?

"Yours faithfully,

"F. J. Foot."

The Rev. S. Haughton, M. D.

X.—Some Remarks on the Doctrine of Characteristic Fossils. By John Kelly.

[Read November 9, 1864.]

In treating of this subject, I shall begin with the Silurian Fossils. An endeavour has been made to arrange the fossils of the Silurian System in bands or zones, supposed to be parallel to the planes of stratification: that the lowest or oldest zones of the sequence contained peculiar fossils; the second, another suite, quite different; and so on with the third, fourth, and fifth zones.

Sir Roderick I. Murchison says, in his "Siluria," Ed. 1859:—"In the Appendix to the former edition of this work, the range of those species only which are common to the great divisions, Upper and Lower Silurian, was exhibited in a tabular form. I am now enabled to give a complete list, so far as our present knowledge extends, of all the species, and to particularize their occurrence in the subdivisions of the system."

The tabular form, so announced, is divided into six zones or columns:—

1. Lingula Flags,	4. Llandovery Rocks,
2. Llandilo Rocks,	5. Wenlock,
3. Caradoc or Bala,	6. Ludlow;

and in those six zones all the Silurian fossils are arranged, accordingly, in the book to which I have above alluded.

On inspecting the table, however, it will be seen that when the fossils were put into these columns, with, we may assume, every disposition both by the author and his *employés*, to keep them in their proper stalls, they often strayed away, and appeared in other stalls, where they had no right to be. One of them, *Stenopora fibrosa*, appeared in no less than five of the Silurian zones; thus, with others, breaking up the arrangement into zones as bands to which they should be confined. More of them had a like tendency. This arrangement does not stand the test of time and discovery. In Galway the Silurian rocks are seen to lie unconformably on the Primary, and this is perhaps the only district in the British Islands where the base of the Silurian rocks is well exhibited. This base is identified by a brown siliceous band of very hard sandstone, or rather quartz rock, without any fossil, about five chains or 330 feet thick, which is persistent for several miles through the country, and mostly affects a horizontal position. It is most important as a geological index in exploring the district. As before stated, this band lies unconformably on the grey mica slate, the yellow quartz rock, and the blue crystalline limestone of that district, as they happen to lie in succession under it, and in ascending it is succeeded conformably by the fossiliferous band, which appears to be about 200 to 300 feet thick. In this band the fossils occur in colonies, and not in zones, as tabulated in "Siluria." The most characteristic of those colonies are in the following localities:—

1. Bunowen, three miles from Leenane, on the Clifden road, where *Atrypa hemispherica* abounds in millions, in a calcareous grey grit, interstratified with conglomerate: six species altogether were obtained here, mostly Brachiopods.

2. Glencraff is three miles east of Bunowen, and in the hills two miles south of the Old Leenane Hotel. 15 species were found here, among which were 2 Trilobites, 6 Brachiopods, 2 Gasteropods, and 2 Cephalopods.

3. Moneenmore, half a mile N.E. of the Maum Hotel; high upon the side of the hill there is a rocky spot; in that there is especially one bed of grey calcareous grit, about 5 feet thick, in which 14 species were got, among which were 2 Trilobites, 2 Brachiopods, 5 Gasteropods, an Orthoceras, and *Bellerophon trilobatus*.

4. Boocaun, a mile west of the village of Fairhill. Here 23 species were found, consisting of 4 Trilobites, 3 Brachiopods, 6 Dimyaria and Monomyaria, 4 Gasteropods, 2 Bellerophons, 2 Orthoceratites.

5. Kilbride is three miles N.N.W. of Cong; it is a promontory which runs eastward into Lough Mask, and on the shore of that Lough is one of the best localities I know to fill a bag of fossils, or ten bags. Here 40 species were obtained, among which were 14 Corals, 6 Trilobites, 17 Brachiopods, 1 Gasteropod, 1 Cephalopod.

6. Tonlegee is on the N. E. shoulder of Benlevy, a mountain six miles west of Cong. This mountain is 1375 feet high. There is no brown quartzite visible here, but a man can stand upon the junction of the crumpled layers of mica slate and the even-bedded layers of Silurian flags lying level and unconformably against them. The Fossils obtained here are included in the following Table, along with the others:—

ABSTRACT TABLE.

Locality.	Corals.	Trilobites.	Dimyaria.	Monomyaria.	Brachiopoda.	Gasteropoda.	Cephalopoda.	Heteropoda, and others.	Total.	Abundance of Fossils.
Bunowen, . .	..	..	..	..	5	..	1	..	6	Brachiopoda abundant.
Glencraff, . .	1	2	1	..	6	2	2	1	15	Middling.
Moneenmore,	..	2	1	1	2	5	1	2	14	Middling.
Boocaun, . .	..	4	2	4	3	4	2	4	23	Gasteropoda abundant.
Kilbride, . .	14	6	1	..	17	1	1	..	40	Corals abundant.
Tonlegee, . .	..	3	5	..	6	9	1	3	27	Middling.

It may be seen by inspection of this Table that some of those localities, and their groups of fossils, have no Corals—some others have more than one-third of the whole of the species found. At Bunowen, with its millions of Brachiopods, there was no Gasteropod. At Boocaun, Moneenmore, and Tonlegee there was no Coral found, but numerous Gasteropods. The fossiliferous appearance in a locality is not owing to variety, but to the great numerical preponderance of one or two kinds. A few other localities were examined, some of them very like one or other of those enumerated; for instance, Cappacorcogue, on the north shore of Lough Corrib, close to Cong, is similar to Bunowen in the millions of *Atrypa hemispherica* that prevail; and Shanballymore, two miles west of Outerard, the same. Ardaun, three miles S. W. of Cong, is most like Kilbride in the numbers of Corals, Brachiopods, and others that prevail in that locality.

I have gone thus perhaps rather far into detail, to show that in colonies or groups the fossils occur in the old rocks of the Galway district, like the oyster beds or cockle strands of recent times, and not in vertical zones, for there is but one fossiliferous zone in that country. Further information on this subject may be had in a paper on this district published in our "Journal," vol. viii., p. 251.

But Sir Roderick himself appears to have abandoned the subdivision of the Silurian series into zones founded on fossil evidence. In a pamphlet circulated by him at the meeting of the British Association at Manchester in 1861, there are several passages which indicate this change of opinion. He first makes a *resumé* of the Primordial rocks of Bar-

rande, in Bohemia; the same as made out by De Verneuil, in Spain; by James Hall, in the United States; by Sir William Logan, in Canada; and the Taconic System in North America; and compares all these with the Lower Silurian of the British Islands.

At p. 9 of this pamphlet some reasoning is given to show that the Fauna of the Silurian series should be separated from that of the Primordial zone, which stratigraphically constitutes its conformable base. He says:—"May we not, therefore, infer that in the sequel other fossil links similar to those which are now known to connect the Lower and Upper Silurian series, which I myself at one time supposed to be sharply separated by their organic remains, will be brought to light, and will then zoologically connect the primordial zone with the overlying strata into which it graduates?"

In this sentence Sir Roderick seems to be relaxing from the six zones. He once thought that the Lower and Upper Silurian zones were permanently distinct; but here he admits that other fossil links may appear similar to those which are now known to connect the Lower and Upper Silurian, "which he at one time thought to be sharply separated by their organic remains." He says again, at p. 11:—"A great revolution in the ideas of many an old geologist, including myself, has been effected. Strengthened and confirmed as my view has been by the concordant testimony of Ramsay, Harkness, Geikie, James, and others, I have no hesitation in considering a very large portion of the crystalline strata of the Highlands to be of the same age as some of the older fossiliferous Silurian rocks, whether in the form of slates in Wales, of graywacke schist in the southern counties of Scotland, or in the conditions of mud and sand at St. Petersburg."

Here is a graceful admission that he was once mistaken in his views of sharp lines separating the zones, in which he thought fossils of different kinds would be found. It is a worthy example to the positive dogmatical school, which sprang up from his teaching, and who still believe that Llandovery rocks can have no fossil in them but what is in his Table in "Siluria." Professor Sedgwick and himself are the geological labourers that did the greatest amount of field work of any two men now living in the British Islands; and if he, in his enthusiasm, made a few mistakes, and corrects them again, as he does here, posterity has no cause to complain.

Regarding Devonian fossils, the authors of the Devonian System say ("Trans. Geol. Soc.," second series, vol. iii., p. 690):—"Mr. Lonsdale, after an extensive examination of the fossils of South Devon, had pronounced them to form a group intermediate between those of the Carboniferous and Silurian systems;" and hence he concluded that the fossiliferous rocks of South Devon were subordinate to the Old Red Sandstone. This view could be effectually maintained only by one who knew the fossils of the Silurian system." As well as the authors of the Devonian system, Dr. Buckland adopted this conclusion, as stated in one of his presidential addresses ("Proceedings of the Geological Society," vol. viii., p. 225), and it may be said to have been adopted by

the geologists of England generally. This deduction of Mr. Lonsdale's was made upon the assumption that all the fossils of the Silurian and Carboniferous systems were known at that time; for he says, at p. 726—"Until the organic remains of the Mountain Limestone and of the Silurian system had been determined, it was vain to speculate on the age of a series of fossils procured from a region but partially examined, beset with faults, and traversed by igneous rocks." It has turned out that it was premature to assume that all the fossils of both systems were then known; for since that time, 1839, Mr. Frederick M'Coy has described 442 new species discovered in Ireland belonging to the Carboniferous rocks, and 82 new Silurian species, in two synopses, printed by Sir R. Griffith in 1844 and 1846. Beside this, Gen. Portlock has added 71 species to the Carboniferous, and 105 to the Silurian; and Major Austin 22 new species to the Carboniferous rocks—in all, 722 new species in the Irish rocks; and no doubt hundreds are yet unknown in both systems. Looking closely into this conclusion of Mr. Lonsdale's, that the South Devon fossils formed a group intermediate between those of the Carboniferous and Silurian systems, there appears to be something wanting. The reasoning seems to be defective. How could any one fossil be intermediate between two others of different kinds? and how could forty Devonian fossils be intermediate between forty of the Silurian and forty of the Carboniferous? If a cockle and an oyster could produce a hybrid animal, that might be an intermediate species, if it had the power of reproduction; but so long as the new-born animal is a cockle, or an oyster, it is not intermediate. It appears, therefore, that the intermediate character given to the Devonian fossils is an absurdity, since they are not either mules nor other hybrids. Part of the Devonian fossils are *common* to both the other adjacent systems, according to my views. They are intermediate, which, I suppose, means *not common*, by Mr. Lonsdale's. It appears to me that this conclusion, so much applauded by learned men, does not bear examination, in the sense in which it was received and adopted. On the principle that certain fossils occur only in particular formations or zones, it has been supposed that the fossils found in the rocks of Devonshire are peculiar to that country, and that the fossils found in the Carboniferous rocks of Ireland are peculiar to that system; but I hope to be able to show that this is not the case, and that many of the Devonian fossils are found in that system in the succession which lies over that series, and some of them in the formation which lies under it; that, in fact, the same fossil sometimes runs through three geological formations. That many of the fossils found in Devonshire and Cornwall, and described in 1841 in "Phillips's Palæozoic Fossils," occur also in the Carboniferous system of Ireland, was first made known by M'Coy, and published in the Synopsis of the Carboniferous Fossils of Ireland, printed by Sir Richard Griffith in 1844. This could scarcely be believed by those who hold to the infallibility of fossils as a test of the age of the rocks in which they are found; and M'Coy, who first laid open this broad fact, laid himself open to much unmerited censure and

aspersion on his labours on account of the discovery. I have heard it said by palæontologists of the present day that he identified the fossils in Sir Richard Griffith's collection erroneously; that this is the reason why a large proportion of the Devonian fossils were supposed by him to be the same as those of the Carboniferous Limestone, and that the fault in question lies with M'Coy, and not with the fossils.

These aspersions appear to have been made by these gentlemen in order to maintain their own views in opposition to M'Coy's results. It is easy, when a man wishes to have a geological fact settled his own way, to cast aspersions on the labours of one who may differ from him in opinion; but it is not so easy in a disputed point to make people believe that he who casts the aspersions is right, and his opponent wrong. Besides the new species described, Mr. M'Coy examined and named many thousands of specimens of Palæozoic fossils in Sir Richard Griffith's collection; he did the same in Professor Sedgwick's collection in the Cambridge Museum. I assisted him in writing the names as he read them off from the Irish specimens, and whenever a specimen was doubtful, he laid it aside for further examination, so cautious was he in this work.

I heard Mr. Salter, a very competent authority, who examined Sir Richard Griffith's collection, afterwards say that M'Coy should not be vilified; that he was a good naturalist, and had a sharp, correct eye. For my own part, I had good opportunities of knowing him, and I always looked upon him as far superior to many who unjustly censured him. He may have made some mistakes. Fossils are often so much crushed or contorted, that it is difficult to know their forms; but I will venture to say, that out of the 440 new fossils of the Irish Carboniferous rocks that he named, not ten, or perhaps five per cent. of them will ever be altered for the better. As for those known before, and figured by Sowerby, Phillips, or Lonsdale, I believe they are all correctly named, and those found in Ireland were all in Sir Richard Griffith's collection in 1842.

In 1853, at the Great Exhibition in Dublin, the whole of this collection was removed to the Exhibition Rooms. In several localities in the North and West of Ireland, some of the most beautiful of the fossils were found in a very soft, black fine-grained shale, as easily disintegrated by exposure to the atmosphere as any of the soft black shales in the Coal Measures. In a dry cabinet this shale might last a few years; but at the time I mention the collection having been moved from Sir Richard Griffith's house to the Exhibition, these tender shales did not bear the agitation of carriage, and many of them crumbled away, and were lost. In 1857, at the meeting of the British Association, many gentlemen visited the collection, and did not find there, of course, all the species described in the Synopsis. I fear this fact led to the depreciation of the character of the cabinet, and perhaps gave rise to the charge of erroneous identification made against Mr. M'Coy.

Some time ago, Mr. Thomas Davidson, the eminent palæontologist, sent me a list, in which he stated that seventy of the species recorded in

the *Synopsis* were not seen by him in any collection in England or Scotland that came under his notice, and were therefore not proven. He was perfectly right in saying they were not proven to him, if he did not see them.

The Carboniferous Slate, or Lower Limestone Shale (for it goes by those two names), contains many of the disputed seventy fossils. In several localities in the North and West of Ireland they occur in this band. Those seventy disputed fossils are Devonian, and it so happens are also in this band, belonging to the Carboniferous system. About twenty species of them were obtained from the soft black shale which occurs at the base of the limestone at Lisnapaste, a locality five miles south of the town of Donegal. Those having been obtained from that perishable black shale are lost, and they cannot be seen again, without a visit to the place, or getting up a few boxes of fresh specimens from it. The little bridge south of the village of Ballynakillew is on this black shale, and the banks of streams and road-cuttings adjacent afford a profusion of the fossils. There are also other localities in which some of the fossils not proven were obtained, as at Bruckless, twelve miles west of Donegal; Bundoran, three miles west of Ballyshannon; Larganmore, two miles east of Bangor, in Mayo; and a few other places.

This subject, showing that the same fossils often occur in the Silurian, Devonian, and Carboniferous rocks, may be best studied in Murchison's "Silurian System;" in Phillips's "Palæozoic Fossils," and in M'Coy's "Synopsis of the Carboniferous Fossils of Ireland." By the help of these works comparisons may be made, and results obtained highly interesting in the pursuit of geology.

The following Table has been made from lists given by Sir Henry De la Beche, in the "Memoirs of the Geological Survey of Great Britain." In a Table so made out, the name of every fossil is a fact, and may at once be controverted if it be wrong. He gives lists of the fossils obtained at three localities of the Devonian country: at Pilton, on the west coast of North Devon, at vol. i., p. 73; at Petherwin, in Cornwall, at p. 80, and at Newtownbushel, in South Devon, at p. 88. In the Table will be found the names of the several fossils, recorded by him, as obtained from those three localities of Devon and Cornwall. In the first column are those got at Pilton; in the second, those got at Petherwin; and in the third, those got at Newtownbushel, the latter by Mr. G. Austen. In the fourth column the Silurian Fossils are marked, and the fifth has a star opposite every fossil of those which has been found in the Irish Carboniferous System, and recorded in the Synopsis, with the name of a locality in which it has been found, upon my own authority. Moreover, no new name, nor any name has been introduced into this Table, but Sowerby's, Phillips's, and other old names, which have not been disputed; only this, that the Irish Fossils have been taken at M'Coy's interpretation, which I believe to be correct.

TABLE.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Turbinolopsis Celtica, . .	*	*	. .	. .	*	Ballinglen, Ballycastle (Mayo).
„ pluriradialis,	*	. .	. .	. .	•	Currens, Tralee.
Manon cribrosum, . . .	*	. .	. .	. .	*	Hook Point, Wexford.
Millepora gracilis, . . .	*	. .	. .	. .	*	Ballintrillick, Bundoran.
Glauconome bipinnata, . .	*	. .	. .	. .	*	Blacklion, Enniskillen.
Fenestella laxa, ...	*	*	. .	. .	*	„ „
„ antiqua, . . .	*	•	*	*	* *	Currens, Tralee.
Pentremites ovalis, . . .	*	. .	. .	. .	*	Ireland (M'Coy) Morris.
Cyathocrinus macrodactylus, ...	*	. .	. .	. .	. .	
Adelocrinus hystrix, . . .	*	. .	. .	. .	*	Ballinacourty, Dungarvan.
Actinocrinus tenuistriatus,	*	. .	. .	. .	*	Carrownanalt, Keadue.
Cyathocrinus pinnatus, .	*	. .	. .	. .	*	Larganmore, Bangor (Mayo).
„ variabilis, .	*	. .	. .	. .	*	Larganmore, Bangor.
Sanguinolaria lyrata, . .	*	. .	. .	. .	*	Ireland (Sow.).
Pullastra antiqua, . . .	*	*	. .	. .	. .	
„ complanata, . .	*	. .	. .	*	. .	
Cypricardia impressa, . .	*	*	. .	*	. .	
Nucula plicata, ...	*	. .	. .	. .	. .	
„ lineata, ...	*	. .	. .	. .	*	Lisnapaste, Donegal.
„ latissima, ...	*	. .	. .	. .	. .	
Cucullæa amygdalina, . .	*	. .	. .	. .	. .	
„ Hardingii, . .	*	. .	. .	. .	. .	
„ angusta, . . .	*	. .	. .	. .	. .	
„ unilateralis, . .	*	. .	. .	. .	. .	
„ trapezium, . .	*	. .	. .	. .	. .	
Pecten polytrichus, . . .	*	. .	. .	. .	*	Ballintrillick, Bundoran.
„ transversus, . . .	*	*	. .	. .	*	Clonea, Dungarvan.
Avicula cancellata, . . .	*	. .	. .	. .	. .	
„ rudis, ...	*	. .	. .	. .	. .	
„ Damnoniensis, .	*	. .	. .	. .	. .	
Leptæna analoga, . . .	*	. .	. .	. .	*	Currens, Tralee.
„ convoluta, . . .	*	. .	. .	. .	*	Hook, Wexford.
„ scabricula, . . .	*	. .	. .	. .	*	Millicent, Kildare.
„ caperata, . . .	*	*	. .	. .	*	Hook, Wexford.
„ membranacea, .	*	*	. .	. .	*	Lisnapaste, Donegal.
Orthis interlineata, . . .	*	*	. .	. .	*	Currens, Tralee.
„ plicata, ...	•	. .	. .	. .	*	Lisnapaste, Donegal.
„ parallela,*	*	*	. .	. .	*	„ „
„ compressa, . . .	*	. .	. .	*	*	Castle Espie, Co. Down.
„ calcar, ...	*	. .	. .	. .	. .	
„ semicircularis, . .	*	. .		*	* *	Currens, Tralee.
Spirifer microgemma, . .	*	. .	*	. .	*	Hook, Wexford.
„ unguiculus, . . .	•	*	*	. .	*	Poulscadden, Howth.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Spirifer decussata, . . .	*	*	. .	. .	*	Lisnapaste, Donegal.
" calcarata, . . .	*	*	. .	. .	*	Millicent, Kildare.
" disjuncta, . . .	*	*	. .	. .	*	Currens, Tralee.
" obliterata, . . .	*	. .	. . .	. .	. .	
" rudis, ...	*	. .	. .	. .	*	Howth, Dublin.
" mesomala, . . .	*	. .	. .	. .	*	Irish locality lost.
" megaloba, . . .	*	. .	. .	. .	*	Poulscadden, Howth,
Terebratula laticosta, . .	*	. .	. .	. .	*	Rahoran, Fivemiletown.
" pleurodon, . . .	*	*	. .	. .	* *	Millicent, Kildare.
Acroculia vetusta, . . .	*	. .	*	*	*	" "
Euomphalus serpens, . .	*	*	. .	. .	*	Oldtown, Co. Dublin; Howth.
Natica meridionalis, . . .	*	. .	. .	. .	. .	
Pleurotomaria cancellata,	*	*	. .	. .	. .	
" aspera, . .	*	*	*	. .	. .	Newton (Morris).
" expansa, .	*	. .	. .	. .	*	Bolland (Morris).
" gracilis, . .	*	. .	. .	. .	. .	
Loxonema rugifera, . . .	*	. .	. .	. .	*	Otterburne, Northumberland (Phil.).
Murchisonia angulata, . .	*	*	. .	. .	*	Bolland (Phil.).
Macrocheilus neglectus, .	*	. .	. .	. .	. .	
Bellerophon Urii, ...	*	. .	. .	*	*	Cookstown, Tyrone (Sil. Mor.).
" trilobatus, .	*	*	. .	*	. .	
" globatus, . .	*	. .	. .	*	*	Derryloran, Cookstown.
Orthoceras Ludense, . .	*	. .	. . .	*	. .	
" imbricatum, .	*	. .	. .	*	. .	
" lineolatum, . .	*	. .	. .	. .	*	Doneraile, Cork.
" tentaculare, .	*	. .	. .	. .	. .	
Calymene accipitrina, . .	*	. .	. .	. .	. .	
" lævis, ...	*	. .	*	. .	*	Clonea, Dungarvan (Morris).
Terebratula acuminata. .	*	. .	. .	. .	*	Millicent, Kildare.
Atrypa oblonga, ...	*	. .	. .	. .	*	Clonea, Dungarvan.
" indentata, . . .	*	. .	. .	. .	*	Lisnapaste, Donegal (common).
" striatula, . . .	*	. .	. .	. .	*	Clonea, Dungarvan.
Leptæna prælonga, . . .	*	. .	. .	. .	*	Lisnapaste (Donegal).
Spirifera extensa, . . .	*	*	. .	. .	*	Currens, Tralee (Peth. Morris).
Avicula pectinoides, . . .	*	. .	. .	. .	. .	
Pecten nexilis, ...	*	. .	. .	. .	. .	
" arenosus, ...	*	. .	. .	. .	*	Millicent, Kildare.
Turbinolopsis Celtica, . .	*	*	. .	.	*	Ballinglen, Mayo.
Amplexus tortuosus, . .	. .	*	*	. .	*	Ballyduff, Dungarvan.
Cyathophyllum cæspitosum, ...	. .	*	. .	*	. .	
Fenestella laxa, ...	*	*	. .	. .	*	Blacklion, Enniskillen.
" antiqua, . . .	*	*	. .	. .	*	Currens, Tralee.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Cyathocrinus variabilis, .	..	*	..	..	* *	Ballintrillick, Bundoran.
,, ellipticus, .	..	*	..	..	*	Carrownanalt, Keadue.
Sanguinolaria sulcata, .	..	*	..	..	*	Hook, Wexford.
Pullastra antiqua, . . .	*	*	..	..	..	
Cypricardia semisulcata, .	..	*	..	*	..	
,, impressa, .	*	*	..	*	..	
,, deltoidea, . .	..	*	..	..	*	Clogher (Portlock).
Modiola amygdalina, . .	..	*	..	..	*	Larganmore, Mayo.
Pecten granulosus, . . .	*	*	..	..	*	Carrownanalt, Keadue.
,, transversus, . .	*	*	..	..	..	
,, alternatus, . . .	..	*	..	..	..	
,, arachnoides, . .	..	*	..	..	*	Ballinacourty, Dungarvan.
Pterinea ventricosa, . . .	..	*	..	*	..	(Sil., Sharpe).
Avicula subradiata, . .	..	*	..	..	..	
,, exarata, ...	..	*	..	..	..	
Leptæna caperata, . . .	*	*	..	..	*	Currens, Tralee.
,, laxispina, . . .	..	*	..	..	*	Salmon, Dublin.
,, fragaria, . . .	..	*	*	..	*	Poulscadden, Howth.
,, membranacea, .	*	*	..	..	*	Lisnapaste, Donegal.
Orthis interlineata, . . .	*	*	..	..	*	Currens, Tralee.
,, parallela, ...	*	*	..	..	*	Lisnapaste, Donegal.
Spirifer protensa, ...	..	*	..	..	..	
,, unguiculus, . . .	*	*	*	..	*	Poulscadden, Howth.
,, lineata, ...	..	*	..	..	*	Millicent, Kildare.
,, decussata, . . .	*	*	..	..	*	Lisnapaste, Donegal.
,, calcarata, . . .	*	*	..	..	*	Millicent, Kildare.
,, disjuncta, . . .	*	*	..	..	*	Currens, Tralee.
,, gigantea, . . .	..	*	..	..	*	Bundoran, Ballyshannon.
,, grandæva, . .	..	*	..	..	*	Currens, Tralee.
Atrypa desquamata, . .	..	*	..	..	*	Ballinacourty, Dungarvan.
Terebratula pleurodon, .	*	*	..	..	* *	Millicent, Kildare.
,, subdentata, .	..	*	..	..	..	
Euomphalus serpens, . .	*	*	..	..	*	Oldtown, Dublin.
Natica nexicosta, ...	..	*	..	..	..	
Pleurotomaria cancellata,	*	*	..	..	..	
,, antitorquata,	..	*	*	..	..	
,, aspera, . .	*	*	..	..	..	
Loxonema sinuosa, . . .	..	*	..	*	..	
,, nexilis, . . .	..	*	*	..	..	
,, tumida, . . .	..	*	..	..	*	Bruckless, Donegal.
Murchisonia angulata, .	*	*	..	..	*	(Bolland Phillips).
Bellerophon trilobatus, .	*	*	..	*	..	
,, hiulcus, . .	..	*	..	..	* *	Ardclogh, Kildare.
Orthoceras cinctum, . .	..	*	*	..	*	Rathgillen, Nobber.
,, laterale, . . .	..	*	..	..	*	Millicent, Kildare.
,, Ludense, . .	..	*	..	*	..	
,, ibex, ...	..	*	..	*	..	

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Orthoceras striatulum, .	. .	*	. .	. .	. .	
Cyrtoceras rusticum, . .	. .	*	*	. .	. .	
Nautilus megasiphus, . .	. .	*	. .	. .	. .	
Goniatites insignis, . .	. .	*	. .	. .	. .	
,, linearis, . .	. .	*	. .	. .	. .	
,, biferus, . . .	. .	*	. .	. .	. .	
Clymenia levigata, . .	. .	*	. .	. .	. .	
,, striata, . . .	. .	*	. .	. .	. .	
,, linearis, . . .	. .	*	. .	. .	. .	
,, fasciata, . .	. .	*	. .	. .	. .	
,, sagittalis, . .	. .	*	. .	. .	*	Bruckless, Donegal.
,, plurisepta, .	. .	*	. .	. .	*	,, ,,
,, valida, . . .	. .	*	. .	. .	. .	
,, granulata, . .	. .	*	. .	. .	*	Clonea, Dungarvan.
Spirifera extensa, . . .	. .	*	. .	.	*	Currens, Tralee (Morris).
Terebratula hispida, . .	. .	*	. .	. .	*	Kildress, Cookstown.
,, indentata, .	*	*	. .	. .	*	Larganmore, Mayo (N. Dev., Morris).
,, triangularis, .	. .	*	. .	. .	. .	
,, striatula, .	. .	*	. .	. .	*	Clonea, Dungarvan.
,, fallax, . .	. .	*	. .	. .	* *	Bruckless, Donegal.
Brontes flabellifer, . .	. .	. .	*	. .	. .	
Calymene Latreillii, . .	. .	. .	*	. .	*	Clonea, Dungarvan.
,, Sternbergii, .	*	. .	*	. .	. .	Pilton (Morris).
Orthoceras cinctum, . .	. .	*	*	. .	. .	Silurian (Morris).
,, ellipsoideum,	. .	. .	*	. .	. .	
,, pyriforme, .	. .	. .	*	*	. .	Silurian (Morris).
,, tubicinella, .	. .	. .	*	. .	. .	
,, ventricosum, .	. .	. .	*	. .	. .	
Cyrtoceras armatum, . .	. .	. .	*	. .	. .	
,, fimbriatum, .	. .	. .	*	. .	. .	
,, marginale, .	. .	. .	*	. .	. .	
,, nautiloideum,	. .	. .	*	. .	. .	
,, nodosum, .	. .	. .	*	. .	. .	
,, obliquatum, .	. .	. .	*	. .	. .	
,, ornatum, . .	. .	. .	*	. .	. .	
,, quindecimale,	. .	. .	*	. .	. .	
,, reticulatum, .	. .	. .	*	. .	. .	
,, rusticum, . .	. .	*	*	. .	. .	
,, tridecimale, .	. .	. .	*	. .	. .	
Nautilus germanus, . .	. .	. .	*	. .	. .	
Goniatites excavatus, .	. .	. .	*	. .	*	Blacklion.
,, globatus, . .	. .	. .	*	. .	. .	
,, serpentinus, .	. .	. .	*	. .	*	Carrownanalt, Co. Rosc.
,, transitorius, .	. .	. .	*	. .	. .	
Bellerophon hiulcus, . .	. .	*	*	. .	*	Yealmbridge (Mor.)
,, striatus, . .	. .	. .	*	. .	*	Ardclogh, Carluke (Mor)
,, Wenlockensis,	. .	. .	*	*	*	Ballinglen, Ballycastle, Mayo.
,, Woodwardii, .	. .	. .	*	. .	*	Bolland (Morris),

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Buccinum acutum, . .	..	..	*	..	*	Millicent, Kildare.
" annulatum, .	..	..	*	..	..	Macr. Schlotheimii (Morris).
" imbricatum, .	..	..	*	..	*	Millicent, Kildare.
" spinosum, . .	..	..	*	..	*	Whitewell (Phil.).
Murex harpula, . . .	..	..	*	..	..	
Pleurotomaria antitorquata,	..	*	*	..	..	Petherwin (Morris).
" aspera, . .	..	*	*	..	..	" "
" cancellata,	..	*	*	..	..	" "
" impendens,	..	..	*	..	..	
" monilifera,	..	..	*	..	*	(Bolland, Morris).
Schizostoma tricincta, .	..	..	*	..	..	
Macrocheilus elongatus, .	..	..	*	..	..	
Terebra Hennahii (Sow.),	..	..	*	..	..	Hen. (Phil.)
" nexilis, . . .	..	*	*	..	..	Lox. nex. (Mor.)
Turritella abbreviata, . .	..	..	*	..	..	
Loxonema reticulata, .	..	..	*	..	..	
" cincta, . . .	..	..	*	..	..	
Turbo textatus, . . .	..	..	*	..	..	
Euomphalus annulatus, .	..	..	*	..	..	
" circularis, .	..	..	*	..	..	
" radiatus, .	..	..	*	..	..	
" serpens, . .	*	*	*	..	*	Oldtown, Co. Dublin; Howth.
Nerita spirata, ...	..	..	*	*	*	Horath, Co. Meath.
Pileopsis vetusta, . . .	..	..	*	..	*	Millicent, Kildare.
Pleurorhynchus aliformis,	..	..	*	..	*	Malahide, Dublin.
" minax, .	..	..	*	..	*	Howth, Dublin.
Modiola scalaris, . . .	..	..	*	..	*	Larganmore, Mayo.
Mytilus Damnoniensis, .	..	..	*	..	..	
Megalodon carinatus, . .	..	..	*	..	..	
" cucullatus, .	..	..	*	..	..	
Pterinea radiata, . . .	..	..	*	..	..	
Avicula texturata, . .	..	..	*	..	*	Clonea, Dungarvan.
" reticulata, . .	..	..	*	.	..	
Pecten plicatus, . . .	..	..	*	..	*	Ballyduff, Dungarvan.
Leptæna fragaria, . . .	..	..	*	..	..	
" nodulosa, . . .	..	..	*	..	*	Currens, Tralee.
" rugosa, . . .	..	..	*	..	*	Millicent, Kildare (= P. analoga).
Orthis arachnoidea, . .	..	..	*	..	*	Millicent, Kildare.
" arcuata, . . .	..	..	*	..	*	Toberelathan, Loughrea.
" crenistria, . . .	..	..	*	..	*	Bundoran, Ballyshannon.
" granulosa, . . .	..	..	*	..	* *	Howth, Dublin.
" Hardrensis, . .	..	..	*	..	* *	Ballyduff, Dungarvan.
" interstrialis, . .	..	..	*	..	..	
" resupinata, . . .	..	..	*	..	* *	Bundoran, Ballyshannon.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Orthis lenis, ...	. .	. .	*	. .	. .	
Spirifer cuspidata, . .	. .	. .	*	. .	* *	Millicent, Kildare.
,, distans, ...	. .	. .	*	. .	*	,, ,,
,, hirundo, ...	. .	. .	*	. .	. .	
,, microgemma, .	. .	. .	*	. .	. .	
,, nudus, ...	. .	. .	*	. .	*	Clonea, Dungarvan.
,, heteroclitus, . .	. .	. .	*	. .	. .	
,, oblatus, ...	. .	. .	*	. .	* *	Millicent, Kildare.
,, plebeia, ...	. .	. .	*	. .	* *	,, ,,
,, phalæna, ...	. .	. .	*	. .	*	St. Doulough's, Dublin.
,, simplex, ...	. .	. .	*	. .	*	Malahide, Dublin.
,, subconicus, . .	. .	. .	*	. .	*	Bundoran, Ballyshannon.
,, speciosus, . . .	. .	. .	*	. .	*	,, ,,
,, unguiculus, . .	*	*	*	. .	*	Lisnapaste, Donegal; Howth.
Stringocephalus Burtini,.	. .	. .	*	. .	. .	
Terebratula acuminata, .	. .	. .	*	. .	* *	Millicent, Kildare.
,, anisodonta, .	. .	. .	*	. .	*	Rahoran, Fivemiletown.
,, aspera, . .	. .	. .	*	*	*	Poulscadden, Howth.
,, bifera, . .	. .	. .	*	. .	*	Millicent, Kildare.
,, cassidea, .	. .	. .	*	. .	. .	
,, comta, . .	. .	. .	*	. .	*	Ballinglen, Ballycastle, Mayo.
Atrypa crenulata,. . .	. .	. .	*	. .	. .	
,, cuboides, . . .	. .	. .	*	. .	. .	
,, desquamata, . .	. .	. .	*	. .	*	Clonea, Dungarvan.
Terebratula ferita, . .	. .	. .	*	. .	*	Millicent, Kildare.
,, flexistria, .	. .	. .	*	. .	*	,, ,,
,, galeata, . .	. .	. .	*	. .	. .	
,, hastata, . .	. .	. .	*	. .	* *	,, ,,
,, juvenis, . .	. .	. .	*	. .	*	Bruckless, Donegal.
,, Mantiæ, . .	. .	. .	*	. .	*	Ireland (Sowerby's authority).
,, prisca, . .	. .	. .	*	. .	*	Shanbally, Cork.
,, proboscidalis,	. .	. .	*	. .		
,, pleurodon, .	. .	. .	*	. .	* *	Millicent, Kildare.
,, pugnus, . .	. .	. .	*	. .	* *	,, ,,
,, reniformis, .	. .	. .	*	. .	* *	,, ,,
,, rhomboidea,	. .	. .	*	. .	*	Howth, Dublin.
,, sacculus,. .	. .	. .	*	. .	* *	Millicent, Kildare.
,, Wilsoni,, .	. .	. .	*	*	. .	Sil. (Mor.).
Cyathocrinites geometricus,	. .	. .	*	. .	*	Currens, Tralee.
,, nodulosus, .	. .	. .	*	. .	. .	
Actinocrinites triacontadactylus, ...	. .	. .	*	. .	*	Manorhamilton, Leitrim.
Platycrinites interscapularis,	. .	. .	*	. .	*	Howth, Dublin.
,, pentangularis,	. .	. .	*	. .		

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Platycrinites tuberculatus,	. .	. .	*	. .	*	Ballinacourty, Dungarvan.
Sphæronites tesselatus,	. .	. .	*	. .	. .	
Stromatopora concentrica,	. .	. .	*	*	*	Howth, Dublin.
„ polymorpha,	. .	. .	*	*	*	Curkeen, Skerries; Dublin. (Sil. Portl.).
Fenestella abnormis, . .	. .	. .	*	. .	. .	
„ antiqua, . . .	*	*	*	*	*	Currens, Tralee. (Sil. Lons.).
Retepora infundibulum, .	. .	. .	*	*	. .	(Sil. Mor.).
„ prisca, ...	. .	. .	*	. .	*	Hook Head, Wexford.
Lithodendron cæspitosum,	. .	. .	*	. .	*	Millicent, Kildare.
Amplexus tortuosus, . .	. .	*	*	. .	*	Ballyduff, Dungarvan.
Cyathophyllum turbinatum, ...	. .	. .	*	*	* *	Benburb, Armagh.
Cystiphyllum Damnoniense,	. .	. .	*	. .	. .	
„ vesiculosum,	. .	. .	*	. .	. .	
Strombodes vermicularis, .	. .	. .	*	. .	*	Benburb, Armagh (Portlock).
Astræa ananas, ...	. .	. .	*	*	. .	(Sil. Mor.).
„ helianthoides, . .	. .	. .	*	. .	. .	
„ Hennahii, . . .	. .	. .	*	. .	. .	
„ pentagona, . . .	. .	. .	*	. .	*	Larganmore, Bangor; Mayo.
Porites pyriformis, . . .	. .	. .	*	*	. .	
Coscinopora placenta, . .	. .	. .	*	. .	. .	Irish locality lost.
Favosites fibrosa, ...	. .	. .	*	*	* *	Killymeal, Dungannon.
„ Gothlandica, .	. .	. .	*	*	*	St. John's Point, Donegal.
„ polymorpha, . .	. .	. .	*	*	*	Hook, Wexford.
„ spongites, . . .	. .	. .	*	*	* *	Millicent, Kildare.

From this Table may be seen the following results:—

	Total.	Silurian.	Carboniferous.
From Pilton, ...	80	11	53
„ Petherwin, ...	72	8	40
„ Newtonbushel, . . .	139	16	71
Total, . . .	291	35	164
Take, . . .	22		22 repeated.
Remains, . .	269		142

Thus it appears that of the whole number of fossils, 269, found in the three Devonian localities, more than half, or 142 of them, occur in the Carboniferous Limestone of Ireland, and 35 of the species are also noted as belonging to the Silurian rocks. Again, 21 species out of 152

are common to Pilton and Petherwin; 11 species out of 211 are common to Petherwin and Newton; and 6 species out of 219 are common to Pilton and Newton. Upon comparing those localities and their numbers, there appears another remarkable result, that there are far more species in any one of the above three Devonian localities common with those of the Irish limestone than there are found in any one of them compared with any other, although the whole three are in the Devonian country.

This result, so far, goes to establish the opinion that the fossils of Devonshire and Cornwall occur in colonies, like those of the Silurian rocks in Galway. A general result, very similar to that obtained from this table, may be seen by analyzing the table given in Phillips's "Palæozoic Fossils," at p. 142. That table gives 277 species got in Devonshire and Cornwall in all the localities examined, and out of those 133 occur in the Carboniferous system. This table, like that made from De la Beche's lists, shows that about half the fossils of Devonshire and Cornwall occur in the Carboniferous Limestone of Ireland—the other half in the Devonian and Silurian formations.

The comparison of the fossils of the Devonian rocks with those of the Carboniferous system is remarkable, in so far that, if fossils were to be the guide, it would lead one to suppose that the whole of the rocks in both belonged to one system. This, however, is disproved by a physical unconformity which occurs between them, where the two are in contact. This is not seen in the South of Ireland, where, like Devonshire, neither the bottom nor the top of the Devonian rocks is visible; but it may be traced in the North, along the S. E. border of the Tyrone Devonian group; at Ballyreagh, to the east of Ballygawley; about Aghnaglogh, one mile N. W. of Clogher; and in the valley of the Tempo River, near Lisbellaw. In those places unconformable junctions may be seen between the two systems. So far as fossils go, Devonshire has enough of peculiar fossils to establish its claim as a subdivision of the transition rocks; it has five species of Cucullæa from Marwood, seven species of Clymenia from Petherwin, and eleven species of Cyrtoceras from Newton. Along with these, there are 88 other Devonian species, in the tables in Phillips's "Palæozoic Fossils," in all 111 published, none of which were yet found in the Irish Carboniferous rocks.

I lately heard a letter read from a palæontologist, in which he stated that the correct succession of the rocks was now only to be determined by the palæontologist. This appears to be going too far; it is putting the accessory before the principal; or, as better expressed in vulgar *parlance*, putting the car before the horse. My views on the use of fossils in geology are these:—That the first of all things to be considered is the physical succession of sedimentary systems, groups, and beds; the lowest known in the foundations of the earth to be the first in the classification; the uppermost to be the last, and so on with all between those; and next, as is shown by the community of fossils between the Devonian and Carboniferous groups, just discussed, that fossils should have only a secondary influence in determining the age of a group of rocks. Stress

has been laid on mineral character and colour; but these are points that cannot be pressed in this matter.

I shall conclude by stating that the views I entertain on this subject are so fully and so clearly expressed in an article in the "Edinburgh Review" for April, 1841, that I shall quote it. The reviewer says of the geologist:—"His primary and essential business is more allied to that of the physical geographer and topographic engineer than of the naturalist. His object is to ascertain the mineral structure of the earth; and interesting and delightful as are the inquiries connected with the study of fossils, the geologist employs his natural history in the first instance as an instrument of stratigraphical arrangement and identification. We should be sorry to be misunderstood upon this point, or to be supposed either to undervalue or to depreciate the importance of palæontology to the science of the earth; but it is only a department, which can never supplant or supply the primary and essential necessity for physical, geometrical, and mineralogical research; and it may be useful to state thus distinctly what appears to us to be the correct view of this matter, as the fashion of the day seems to run in an opposite direction, and to give an undue proportionate value to the study of fossils alone."

XI.—On the Geology of the New Zealand Gold-fields.* By W. Lauder Lindsay, M. D., F. R. S. Edin., &c., &c.; Honorary Fellow of the Philosophical Institute of Canterbury, New Zealand.

[Read January 11, 1865.]

In the following Paper I do not aim at a topographico-geological description of *all* the New Zealand Gold-fields, which are now very numerous, and may be said to extend, with intervals, from the extreme north of the North Island to the south of the Middle Island. Such a description would, from the varying character of these Gold-fields, occupy a bulk which I do not propose, at present at least, to devote to the subject. My present object is simply to give a general idea or sketch of the geological character of the New Zealand Gold-fields. For this purpose I select two Diggings as types of the others, for various reasons, and especially for these,—that, so far as I am aware, all the other Gold-fields may be classed in the category to which belong one or other of the two selected, or a combination thereof; and because they are the two with which from personal examination I am most familiar. The Gold-fields, or "Diggings," referred to, are those of *Otago* and *Auckland*, respectively; the one in the Middle, the other in the Northern Island—the one representing *alluvial mining*, as it is technically called; the other *quartz reefing*.

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* Drawn up in 1862, immediately after a visit to the Gold-fields of Otago and Auckland, New Zealand.

My remarks, moreover, apply to 1862, the period of my visit to the Gold-fields in question. I have not since seen reason to alter any of my opinions, or modify the results or records of my personal observations; on the contrary, the mining experience of the last two years has only served to confirm the predictions or assertions I ventured to make while on the spot.

I.—OTAGO GOLD FIELDS.

In January, 1862, I paid a visit of some days, with a view to a brief geological survey, to the now celebrated, but then recently opened, *Tuapēka* Gold-field in Otago, inspecting in detail the three great "Diggings" comprised within its boundaries, viz.:—those of Gabriel's and Monroe's Gullies, Wetherstone's, and Waitahūna. During the three previous months my head-quarters, whilst engaged in a natural history survey of part of the province of Otago, had been on what is equally entitled *geologically*, though perhaps not *commercially* speaking, to the appellation of a "*Gold-field*," at Saddle-hill, about seven miles northwards from Dunedin, its capital.

Subsequently to leaving Otago I visited the other provinces of New Zealand. At Nelson I had the opportunity of examining gold from all the Gold-fields of that province. At Wellington Dr. Fetherstone, the Superintendent, showed me the gold of Terawiti, about twelve miles from the town of Wellington. And while established at Auckland for a few weeks, I spent some days on the Coromandel Gold-field, which is now rapidly rising into note, examining its geology in connexion with Mr. Simmonds, a gold miner of great Victoria and Otago experience, and who was subsequently appointed by the Government of Auckland director of the gold-prospecting parties in Coromandel.

From New Zealand, I passed over to New South Wales; and in Sydney had the advantage of inspecting the extensive and valuable Geological Museum of the Rev. W. B. Clarke, the most eminent of antipodean geologists, the vaticinator and pioneer of almost all the now famed Australian "Diggings," as well as the predicter in 1851 of the existence of gold in New Zealand. This museum is particularly rich in the gold-bearing rocks and gold of Australia and Tasmania. Nor did the geological collection of the well-arranged "Australian Museum" at Sydney fail in information concerning the same Gold-fields.

On return to this country I inspected the gold collections, as well as the series of associated auriferous rocks, where the latter exist, in the International Exhibition (London, 1862), the British Museum, and Museum of Economic Geology, London, and the Museum of Natural History in the University of Edinburgh; and I sought out the most recent information on the geology and mineralogy of gold and of auriferous rocks—all with a view to a comparison of the Otago gold and gold-bearing strata with standards with which we are familiar at home.

The scope of my present communication will not allow me to do more than merely *epitomize*, or give very briefly the general results of

my observations or investigations; but this may suffice to satisfy the natural curiosity of the geological student regarding the natural history of one of the most recently developed and most important series of our colonial Gold-fields, and indicate how far the auriferous system of Otago resembles that of Australia, California, Brazil, Russia, Scotland, Wales, Ireland, or other auriferous countries, which are geologically better known to us.

I would concisely tabulate my results as follows :—

1. The golds and gold-bearing rocks of Otago do not differ essentially in mineralogical or geological characters from those of any other part of the world hitherto known to be auriferous.

2. The gold occurs originally in a quartz matrix, and this auriferous quartz occurs interbedded in, or associated with, metamorphic slates, especially gneiss, chlorite, and mica slates; the latter frequently highly ferruginous. These slates vary greatly in mineral character; in external appearance they are precisely similar to the corresponding rocks of Scotland (Grampians).

3. The slates in question are probably of *Silurian* age; this has as yet, however, to be *proved*. No fossils have hitherto been detected, and the subjacent rocks are apparently *granitic;* the *supposition* is hazarded mainly on the general resemblances, stratigraphical and lithological, between the slates in question and those of Australia, Russia, and Scotland.*

4. At various points in Otago there are evidences of considerable disturbance in the schistose strata by eruptive trappean masses. To such disturbance may be referred the frequent and sometimes sudden variability of dip within a comparatively limited space, the occasional faults and distortions of strata, and the accumulation of masses of "chopped slate" on the very irregular and frequently upturned edges of the mica and other slates.

5. Hitherto the "diggings" have been confined to the drift or alluvial deposits immediately superjacent to the slates in question, as these

* The parallelism between the auriferous slates of Otago and Scotland is remarkable. I was struck with it while in Otago, and I have since traced and proved it by a personal examination of the Highlands of Dumfries, Lanark, Peebles, and Perthshires. The Lead Hills' district, for instance, may be said to be a second edition of Tuapeka—the configuration of hills and glens is the same; their geological formation is similar; gold is procurable under precisely similar circumstances, although in smaller amount, and there are to be seen in various parts of its glens and flats vestiges of the "diggings" of a bygone age. To this day, the lead miners, while idle on a holiday here, collect *alluvial gold;* and these specimens, specially collected for me by some of these men, exactly resemble the gold of Gabriel's Gully. My investigations satisfied me that gold is generally distributed, though in small quantity, throughout the metamorphic slate districts of Scotland, which extend from the extreme north (Sutherland) to the extreme south (Wigtown) of the country.

The Coromandel Gold-field, in the north Island, has in respect of its quartz reefs a greater resemblance to the Gold-fields of North Wales (about Dolgelly, in Merionethshire).

occur especially in the "flats" on the banks of streams, or at the opening out of glens or valleys. These deposits, or "drift," consist essentially of,

a. Clays or tills, mostly blue or yellow;

b. Boulders, generally boulder clays;

c. "Gravels," so called; but which are really more properly what the miners denominate "chopped slate," chiefly formed of the *debris* of the subjacent and circumjacent slates or other rocks, seldom or little rounded or water-worn. According to the character of the slates from which they are derived, these clays and gravels are coloured red or yellow, blue or green—the ferruginous mica slates being the origin of the first-named colour, gneiss of the second, and chlorite slates of the third.*

6. The auriferous "drift" appears to be of newer *Tertiary* age, this supposition being based on such facts as the *sub*-jacency of *lignites*, or brown coals, which are referable to the *older* Tertiaries.

7. The gold is partly granular, partly scaly, partly nuggety, and partly crystallized, and exhibits every gradation, intermixture, and variety of each of these forms or kinds.

8. It is associated, in different localities, with titaniferous magnetic iron sand, iron pyrites, garnets, and other minerals.

9. Metamorphic slates are probably the fundamental rock of Otago, that most widely distributed. Speaking in general terms, wherever they have hitherto been specially examined, they have proved to be auriferous; and wherever they may still be found, gold may reasonably be looked for. Gold has already been found in the gravels of the Mataura River; on the Waiopai Plains; in the Tokomairiro Plains; in the Woolshed, which lies between Tuapeka and the Tokomairiro; in the Waipori district; in the iron sand of the beach at Moeraki; near Waikowaiti; in the Lindis Burn, in the extreme north, and in many other localities; and I have no hesitation in affirming that it will yet be found much more widely, probably generally diffused, though nothing short of actual mining or digging can determine the exact localities of "payable Goldfields."

10. I consider the auriferous capabilities of Otago only in gradual process of development. Hitherto the operations of miners have been mainly confined to what are called "alluvial" or shallow diggings. Scientific quartz mining has not as yet been engaged in. The experience of all auriferous countries proves that in proportion to the richness of drift deposits, they are soon exhausted; that their richness, however, is an indication of the fertility of the quartzites from which the drift or alluvial gold has originally been derived; that these quartz-

* The gold occurs chiefly in the so-called "gravel" or "chopped slate," which constitutes the "wash dirt" of the miner. It is frequently found most abundantly in "pockets" or crevices of the irregular upturned edges of the slates, on which the said gravel immediately reposes. It is also disseminated through the clays in many localities, and sometimes is collected in quantity in cavities under the boulders in the boulder clays.

ites are what gold miners must look to for *permanent* employment. It is regretable that the capabilities of the Otago auriferous rocks may not be tested or developed so fully and so speedily as is desirable, in consequence of the unfortunate position taken by the Otago Government towards the immigrant diggers or gold miners, who are mainly Australians. At the period of my visit these miners were very much dissatisfied with the policy and practice of Government, and there was then every reason to apprehend an exodus of diggers from Otago back to Australia on the approach of winter. It was then a subject of complaint that nothing was being done by Government towards the formation of roads in the Tuapeka district, existing roads being mere hill tracks, nearly impassable in wet weather; nothing towards the sale of adjacent lands, and the permanent location of a large proportion of the mining population; nothing towards the establishment of a market town, with all its advantages; nothing towards working the adjacent brown coals, or otherwise supplying winter fuel; nothing towards reform in unsatisfactory or impracticable mining laws. I trust, and indeed there is every reason to believe, that much of this unsatisfactory state of matters has been amended, though I have doubts as to whether it has been done sufficiently in time to prevent a reflux of a large proportion of the Australian population. Among other circumstances affecting the mining population in Otago, and thereby the development of its auriferous resources, may be mentioned the gradual rising into notoriety of the Gold-fields of Nelson and Auckland, which has determined a "rush" of diggers northwards; and the general dislike of Australians to the climate of Otago, particularly its winter climate, which they say contrasts most unfavourably with that of the majority of the Australian Gold-fields.

11. An estimate of the productiveness of the Tuapeka Gold-field may be formed from the following Table, extracted from the columns of a local newspaper:—

Amount of Gold exported from Otago.*

Years.	Ounces.
In 1861 (last six months), ...	187,695
In 1862, ...	397,602
In 1863, ...	580,233
In 1864 (first 7½ months), ...	333,982
Total, from the discovery of Tuapeka, in July, 1861, . .	1,499,512 †

representing in value about five millions sterling.

* This is exclusive of the considerable quantities of gold passing through *private* channels, and which cannot be precisely estimated.

† "Otago Daily Mines," August 18, 1864, taken from the Custom House returns.

I have repeatedly heard Otago miners of both Californian and Australian experience declare that no space of ground of equal extent in either of the countries just named had ever produced the same amount of gold within the same period as Gabriel's Gully, Tuapeka. However this may be, it would appear that the experience of Tuapeka has been that of Gold-fields in general: there has been an alternation or intermixture of great gains and great losses, some miners amassing fortunes, while others have been beggared. At the time of my visit, however, there was a population of about 12,000 persons in the various Tuapeka diggings, while the minimum or average wage for a common day labourer was one pound per day.

12. The provincial Governments of Southland, Canterbury, and Wellington, have lately offered substantial premiums (generally £1000), for the discovery of "payable Gold-fields" within the precincts of these respective provinces, a circumstance which will probably stimulate the energies of prospecting parties, and lead perhaps to the extension or multiplication of the existing Gold-fields of New Zealand. I have every reason to believe that new Gold-fields remain to be discovered; at all events I have no doubt as to the general distribution of auriferous slates belonging to one or other of the gneiss, clay slate, mica slate, talcose, or chlorite slate series over the whole New Zealand Islands, North and South, interrupted here and there, and to a varying extent, by formations of more recent origin, and consisting, largely at least, of the *débris* of these slates.

13. In order to afford an estimate of the present position and prospects of the various Gold-fields in Otago, I append quotations from the most recently arrived Otago newspapers, these quotations consisting mainly of the narratives of the various newspaper correspondents.

II.—AUCKLAND GOLD FIELD.

In February, 1862, while sojourning for a time in the town of Auckland, in the North Island, I spent some days in a rough geological survey of the *Coromandel* Gold-field, distant about fifty miles from the capital, across the Frith of the Thames. This Gold-field and its products, though in certain respects they resemble, in certain others differ somewhat from, the Gold-fields of Otago as already described. By way of contrast or comparison, and as serving more fully to illustrate the general geology of the New Zealand Gold-fields, I have deemed it desirable to supplement my notes on those of Otago by similarly brief or concise remarks (being, as in the former case, simply the general results of my observations or investigations) on that of Coromandel, in the province of Auckland, geographically some 800 miles distant from, and further north than, the Tuapeka field in Otago.

The Coromandel Gold-field differs from that of Tuapeka in having been longer known, and in having been previously "worked," if the efforts of the few dozens of Auckland citizens who dug gold there in 1852 be entitled to this appellation. According to one of the most

reliable historians of New Zealand, the late Dr. Arthur Thomson,* the field was deserted after a few months' occupation, the total yield of gold being 300 oz., or £1100 worth, which was collected at an expense of £2000 worth of labour! This experiment was felt by all parties to be unsatisfactory; curiosity was excited—anticipations given birth to; but it was not *proved* that Coromandel was a "payable Gold-field," a very small portion of it indeed having been at all operated on. Nothing further was, however, done towards the development of the auriferous resources of the Coromandel peninsula till the recent outbreak of the gold mania in Otago (1861). A sense of the advantages conferred on Otago by the possession of its valuable Gold-fields led the Auckland Government to consider the means of drawing a proportion of the immigrant mining population towards Coromandel. Negotiations were entered into with the native proprietors of that peninsula, and the result was a permit from the latter for European "*prospecting*" of a *portion* of their lands for gold. This privilege was set forth in such terms in the Auckland newspapers as to draw northwards from Otago a few dozens of the more restless or enterprising of the Australian gold miners. Disappointment and discontent on the part of the latter were the speedy result: they accused the Auckland Government of virtual misrepresentation, and certainly with every appearance of justice. The Auckland public prints, said they, set forth in much too favourable a light the privilege to be enjoyed, the auriferous riches of the ground open to prospecting, and the extent of district to be so prospected. They found the privilege of prospecting hedged round with so many restrictions as to be really of little value: certain large tracts of land were exempted; the Maori cultivations on the "flats" about Coromandel harbour—consisting of auriferous "drift"—were tabooed; and certain boundaries were established, over or beyond which the digger might not trespass. It so happened that these exempted or forbidden portions of land were just those which promised to be most auriferous—just those which the instinct of the miners led them to desire to prospect. Moreover, the privilege awarded was simply one of "*prospecting*," not of "*working*:" it was set apart for the enterprising miners to work out the problem whether the Coromandel Gold-field was a "payable" one; and in the event of this being determined in the affirmative, a basis would simply be afforded for further negotiations—for "working" the said Gold-field—between the Auckland Government and the Coromandel natives, it being by no means certain that the useful workers or solvers of the problem would ever be adequately rewarded, or rewarded at all for their toil and their risks. At the period of my visit, I found the few miners then on the spot so much discouraged by the state of affairs just referred to—by the incessant interferences of the Maori proprietors of the soil—the deficiency of proper mining tools in Auckland—the absence of stores of

* "Story of New Zealand," vol. ii., p. 197. London: 1858.

food—and the want of government assistance and patronage, that they were fast leaving Coromandel in disgust, bound either for Australian or for the Nelson "diggings." These men had not been afforded any proper opportunity of working out the experiment or problem as to the payable or remunerative character of the Coromandel Gold-field, while there seemed no difference of opinion in Auckland as to the desirability of a speedy solution of the question. So satisfied was I, on the one hand, of such desirability of setting forthwith at rest the question, "Whether or not the province of Auckland possessed a payable Gold-field at Coromandel, or elsewhere," as bearing most intimately, not only on the immediate welfare of the province, but on the more general and more serious so-called "Native question," which more or less involves the prosperity of the whole Northern Island of New Zealand; and, on the other, so convinced of the auriferous character of the Coromandel peninsula, and of the suitability of the Australian miners for practically deciding the *quæstio vexata* immediately at issue, if properly supported, and afforded the indispensable opportunities—that I united with a party of Otago miners, who had been my *compagnons de voyage* from Dunedin, in making strong representations to the Auckland Government, with a view to secure, *firstly*, a Government grant in aid of the efforts of the prospecting parties, to furnish them with tools and rations for a given period; and, *secondly*, more extended and real privileges in regard to the character and space of the district to be prospected. Apparently the Government and public of Auckland were quite alive to the desirability of both these aims or schemes; for a grant of £500 was forthwith made, and Mr. Simmons, one of the Otago miners in question, was appointed to the charge and disposal of this prospecting grant, and to the supervision of the prospecting parties. The services of the nomadic diggers were therefore retained for behoof of the province; and since that period (February, 1862), they have been zealously at work, with what success the public prints of Auckland satisfactorily show. The existence of a "payable Gold-field" can scarcely be said yet to be *proved*;* but this is not the fault of the prospecters. The error lies in the unsatisfactory relative position of the natives and Government in reference to the possession of the Coromandel peninsula. My conviction is firm, that so long as that tract of country is in possession—in part or whole—of the natives, it will be impossible to develope to the full extent, or perhaps at all satisfactorily, its auriferous resources, save at the risk of a serious collision between

* That Coromandel is now (1864) a "payable Gold-field" there can be no doubt. It has been proclaimed so long since by the Government of Auckland. Numerous joint-stock companies have been formed to mine and crush the quartz, and extract the gold; suitable machinery has been procured from Australia; numerous mines are in full operation; and the whole district visited by me in 1862 is now a scene of the busiest and most prosperous mining industry—a scene which probably attracts but little attention, simply by reason of the superior or more immediate interest attachable for the present to the guerilla war of the restless Waikatos and Taranakis.

the two races, the Maori proprietors and the European immigrants—the consequences whereof it is difficult to estimate or predict. It seems to me that the Auckland Government has erred grievously in not having long ago purchased the freehold of the entire Coromandel district, which in fact was at one time offered for sale by the natives at a very cheap rate. Independently altogether of its gold, this district is rich in valuable timber; and it contains some of the finest scenery in the neighbourhood of the capital of New Zealand—scenery that, under happier auspices, might establish at Coromandel harbour the Brighton or Portobello of Auckland.

I. The geology of the northern Gold-fields of New Zealand, including those of the provinces of Nelson and Auckland, does not differ essentially from that of the southern or Otago Gold-fields, as already described, save in so far as concerns certain minor details. The auriferous slate, for instance, is more usually clay slate than mica or chlorite slates; the associated quartzites are developed to a much larger extent, and the evidences of trappean disturbances are more numerous in many cases. Nor does the character of the gold itself differ materially, save in so far, perhaps, as at Coromandel it is more usually associated with its quartz matrix, mostly in the form of quartz pebbles.

II. At Coromandel the auriferous clay slate is scarcely visible; the whole district is mountainous, and is more or less covered with a dense virgin forest, more of the nature of Brazilian jungle than of the Australian "bush," rendering a geologist's researches extremely difficult. It is only here and there in the beds of streams or ravines that the slate occasionally "crops out;" nor is the quartz, which is largely interbedded in or associated with the slate, itself frequently to be met with *in situ;* here and there only it is to be found as a huge, irregular, wall-like mass or "dyke," forming the ridge, perhaps, of the great central dividing range of mountains. But the proximity and abundance of quartz are sufficiently indicated by the great numbers of huge quartz boulders or blocks which are strewn over the flat grounds, about the head of Coromandel harbour, and at the foot of the said dividing range. These blocks are generally more or less angular, though the angles are usually somewhat rounded off, their appearance indicating no great distance from their native "reefs" of quartz. In various parts of the district these quartz masses are accompanied by similar masses of basalt, which, however, are generally more waterworn, and appear to have travelled further from their origin.

III. The dividing range of the Coromandel peninsula consists of a backbone of mountains varying from above 1000 to 3000 feet of elevation, and runs nearly north and south—a direction which is by gold miners supposed to indicate, or be favourable to, auriferous riches, but which supposition is not always borne out by facts. The auriferous quartz reefs, which, from their superior hardness, usually project above the surface of the softer slates, forming frequently serrated, narrow, ridges, generally run in the same direction as the dividing range.

IV. The slates of Coromandel are very much altered by the trappean rocks with which they are generally more or less intimately associated. They are generally very much hardened, and they bear so great a resemblance to slaty basalts, particularly of the clinkstone class, as to be almost indistinguishable by the naked eye. Where they occur, or are laid bare, in ravines or streamlets, they are generally found more or less vertical or tilted up very obliquely, as in the bed of the Waiau, which forms the southern boundary *politically*, though not geologically, of the Coromandel Gold-field.

V. The prevalent trappean rocks, which burst through, overlie, or are otherwise associated with the slates, are mainly various tuffs and basalts. On the island of Wanganui, in Coromandel harbour, which was my head-quarters, I found a very hard breccia, formed to a great extent of fragments of jasper and flint, and various tuffs, which appear as if made up of the *débris* of *granitic* rocks; while boulders of syenite and basalt were scattered over the surface of the hills. This island seemed altogether trappean, composed mostly of tuffs or breccias.

Local geologists, such as Messrs. Heaphy and Swainson, describe the fundamental rock of the Coromandel mountain chain as granitic; and the granite as forming here and there the apices or aiguilles of the said chain or ridge. The papers of Mr. Heaphy especially (who was Gold Commissioner at Coromandel in 1852), in the "Journal of the Geological Society," * may be referred to with great advantage on the subject of the general geology of Coromandel.

VI. The Coromandel "Diggings" have hitherto been through the same superficial deposits, or "drift," as those of Otago. This drift consists essentially of,

1. Clays of different colours, more or less free from boulders;
2. Clays containing boulders, which are mostly trappean (basaltic); and,
3. Gravels, of the "chopped slate" character (apparently the *débris* of the component rocks of the adjoining ranges or mountains), resting immediately on the "bed rock," or slates.

In the latter, the gravels, as at Otago, the gold mostly occurs.

VII. But these auriferous "drifts" are comparatively of limited extent; the "flats" bear a small proportion to the mountain ranges, and are not likely of themselves long to support a large mining population. On the other hand, there is every evidence of abundant auriferous quartz "reefs;" and it appears to me altogether that the development of the auriferous riches of this district must be mainly by means of *scientific quartz mining*,—an operation that requires not only a high degree of skill, but a large amount of capital. This Gold-field differs

* "On the Coromandel Gold Diggings in New Zealand," vol. x., p. 322 (1854); and "On the Gold-bearing District of Coromandel Harbour," vol. xi., p. 31 (1855).

materially in its characters from that of Tuapeka: there you have a bare open country, consisting of gently undulating "ranges," like the lower parts of our Lammermoors or Ochils; "flats" are prevalent, large open level valleys, and accessible streams; auriferous drift is abundant, while quartz reefs are developed to a comparatively small extent. Here, on the other hand, is a rugged, inaccessible, mountainous, densely-timbered country, cut up by deep, sometimes precipitous gorges or ravines; the flats at the mouths of valleys insignificant; the drift sparingly distributed, while quartzites are developed to a comparatively large extent. It is evident, under these differences of physical conditions, that the nature of the gold mining must also be very different in the two places. It is as yet impossible to hazard any estimate or opinion as to the auriferous richness of the Coromandel quartzites. The abundant experience of Australia, and more recently of the Welsh gold mines, shows that the extraction of gold from auriferous quartzites, which contain no gold visible to the naked eye, may yet be most remunerative, though it shows, further, that the degree or extent of this remunerativeness differs greatly on the nature of the processes employed, processes based partly on chemistry, partly on mechanics, the result of the most recent applications of science. I have a high opinion of the auriferous richness of these Coromandel quartzites, and of the yield they will give, when science is properly applied to the extraction of their wealth; and I may make the same remark in regard to the auriferous quartzites of Otago and Nelson.

VIII. Coromandel gold occurs in the granular, scaly, and nuggety form, frequently as scaly nuggets. What I saw was generally inferior in quality to the greater part of Otago gold, and more resembling in value some of the Nelson gold. But the specimens submitted to me by the gold miners were usually contained in rounded quartz pebbles, the quartz frequently of a brownish or ochrey colour; the gold was generally disseminated in such a manner through the quartz as to have a dendritic appearance or character; the pebbles seemed frequently richly veined with the finest gold. The quartz blocks so abundantly scattered over the flat lands about the head of the Coromandel harbour, and up the valleys of the Kapunga and Waiau, frequently consist of the porous spongy quartz so common on many of the Australian diggings, and its colour is frequently buff, brown, ochrey, or vermilion tint, the result apparently of ferruginous impregnation. The shingly bed of the Kapunga stream, on the banks of which the earliest diggings were situated, consists mainly of *débris* of a dirty brownish-yellow quartz. The quartz fragments and blocks become more numerous and larger in proportion as we approach the mountain ranges.

IX. The drift gold is associated at Coromandel with titaniferous iron sand, exactly resembling that which is so well known as the produce of the beach at Taranaki; it seems to occur along with gold in almost all of the New Zealand Gold-fields.

X. "Gold has been found at Victoria, in the interior of the North

Island of New Zealand," says Dr. Thomson.* This locality is at the south end of the range of mountains which forms the backbone of the Coromandel peninsula. There is every probability, I think, that this whole range, which according to local geologists would appear to consist of Silurian slates, is, along with the drifts therefrom derived, auriferous. Not only so—gold has been recently found in other districts of Auckland province, and at Rangitik, Taranaki, and other localities in the province of Wellington. From the description of the prevalent rocks given me by settlers in other parts of these provinces, particularly of Auckland, I feel little difficulty in predicting that auriferous rocks and deposits will yet be found much more widely scattered than is at present known over the North Island of New Zealand, perhaps more particularly in the province of Auckland. I would venture strongly to recommend, therefore, not only systematic prospecting for gold, wherever the metamorphic slates occur, but in all the drifts derived from granitic and hornblendic rocks. In Australia, and other auriferous countries, gold is frequently derived from granites and syenites. In New Zealand this is very seldom the case; but there is at least one good instance, according to Haast, in the province of Nelson, in the bed of the rivers Roto-iti and Rotoroa, where the gold could apparently only have been derived from the decomposition of rocks of a granitic or hornblendic character. I would strongly commend this circumstance, that Silurian slates are by no means the only sources of gold even in New Zealand, to New Zealand gold miners, convinced as I am that much remains to be done to adequately develope the auriferous resources of that country—resources of which, in reality, little can as yet be said to be known. But I would go further, and point out to the Government of Auckland the fact that the present unsatisfactory information as to the gold-bearing rocks of that province is only one illustration of the extreme desirability of a thorough and immediate *geological survey of the province.* Another perhaps equally forcible illustration may be found in the coals or lignites of Auckland, which are only now beginning to be worked and applied to useful purposes; but only a few deposits or beds of which are known, as compared with those which I have little doubt remain to be discovered. Otago has taken the lead in the appointment of a competent geological surveyor, and in the initiation of a systematic geological provincial survey; Wellington is following. Nelson and Canterbury have had partial surveys of a superficial kind; and Auckland, which should have set the example, is still greatly behind the times in this respect, and is thus standing very materially in its own light. It is true that the geologist of the Austrian Exploring Expedition, Dr. Hochstetter, of the "Novara" frigate, has made valuable contributions to the geology of Auckland; and in noticing such contributions we must not omit to mention the repeated and most interesting geological papers of the present Surveyor-General of Auckland

* "Story of New Zealand," vol. ii., p. 198.

Mr. Heaphy, or the labours of other *local* geologists. But these labours have achieved little compared with what remains to be achieved, and which can only be accomplished by a regular geological survey, extending over several years, and implying an expenditure of from £5000 to £10,000.

XI. It is difficult to form a comparative estimate of the auriferous richness of the North and Middle Islands of New Zealand. So far as I have been able to judge from personal observation, from the narratives or papers of geological and other travellers, and from the descriptions of settlers, there seems reason for supposing that the auriferous slates are more largely developed in the Middle than in the North Island, and that, consequently, the yield of gold should be greater in the former. It is, perhaps, of little importance to speculate at present on this subject, seeing that there can be no doubt, I think, that auriferous rocks and deposits abound in *both* islands to an extent that will require years to determine, and that the development of the auriferous resources of New Zealand is yet in its infancy. It will not fail to be observed that the obstacles to the development of the Gold-fields at Coromandel differ entirely in character from those in Otago; in the former they are altogether of a more formidable kind. The possession of the soil by the Maoris is the first great barrier to progress at Coromandel, though the physical nature of the country is one scarcely of subordinate importance. But, these obstacles being successfully overcome, there are advantages at Coromandel not possessed by Otago. Among these may be mentioned proximity to Auckland, and easy carriage of stores and tools, abundance of timber for fuel, houses, and mining, and a very superior climate, leaving out of view romantic scenery, which, though not directly influencing the miner, perhaps does not fail to add to the amenities of his existence.

The present position and prospects of the Coromandel Gold-fields may be gathered from the appended quotations from Auckland newspapers, recently received. From these it would appear that the efforts of the diggers have been greatly facilitated by an extension of the prospecting privileges, as well as perhaps by other privileges or advantages secured from the natives by Sir George Grey. Past experience, however, teaches me, I regret to say, to accept all such *newspaper* accounts *cum grano*, and to allow a wide margin for differences between the representation and the reality. There seems no reason to doubt, however, from whatever causes, that progress is being made, though slowly, let us hope surely, in the development of the auriferous resources of Coromandel, and of the North Island of New Zealand generally.

"Two escorts have reached town since our last summary, bringing down gold as follows:—23rd August, 14,088 oz. 11 dwt.; September 6th, 12,637 oz. 11 dwt.; total, 26,726 oz. 2 dwt. The total export of gold from New Zealand, from 1st April, 1857, to 30th June, 1864, is 1,554,069 ounces, of the value of 6,015,630*l*. The ex-

ports are thus divided:—From Auckland, 26,939*l.*; Nelson, 262,867*l.*; from Nelson and Picton (being the produce of Marlborough Gold-field), 27,919*l.*; Canterbury, 91*l.*; Dunedin and Bluff (being the produce of Otago Gold-fields), 5,697,814*l.* The exports of the quarter ending 30th June were:—Auckland, 5,095*l.*; Nelson, 17,676*l.*; Marlborough, 27,919*l.*; Canterbury, 91*l.*; Otago, 537,658*l.*—making in all for the quarter an export of 588,439*l.* From this it will be seen, that in proportion to our population, which was reduced by at least 10,000 during the first six months of this year, that the yield per man of our Gold-fields was greater during that period than during any previous half year."—*Otago Mail*, September 17, 1864.

"GOLD STATISTICS.

"The quantity of gold exported from the province of Otago during the current year to this date is 361,995 oz. 2 dwt.

"The quantity previously exported is as follows:—

Years.	Oz.
1861,	187,695
1862,	397,602
1863,	580,233
	1,165,530

Making a grand total since the discovery of the Gold-fields of 1,527,525 oz. 2 dwts., the value of which, at the English Mint price, is nearly 6,000,000*l.*

"The escorts have brought down the following quantities of gold during the current year:—

Month.	Oz.	Dwts.
January 12,	15,766	6
" 26,	16,569	8
February 9,	21,780	7
" 27,	16,262	0
March 12,	14,936	3
" 23,	22,678	15
April 6,	21,435	11
" 19,	22,214	0
May 3,	22,565	5
" 17,	17,172	1
Carried forward,	191,379	16

Month.	Oz.	Dwts.
Brought forward,	191,379	16
May 31,	13,108	0
June 14,	12,732	18
" 29,	10,411	0
July 12,	12,692	7
" 26,	11,721	0
August 9,	14,917	15
" 23,	14,088	11
September 6,	12,637	11
Total,	293,688	18

"*Otago Daily Times*," September 17, 1864.

XII.—Description of a New Palæchinus. By Joseph Wright, Esq.

[Read March 9, 1864.]

The first notice we have of the genus Palæchinus was in a short paper read by Dr. Scouler before this Society in 1840, when two specimens were exhibited; but these were so deeply imbedded in the stone, that little could be ascertained respecting their structure. Four years afterwards, Sir R. Griffith published his great work on the Irish Carboniferous Fossils, and in this Mr. M'Coy figured and described no less than five distinct species of Palæchinus, all of which were peculiar to the Carboniferous rocks of Ireland.

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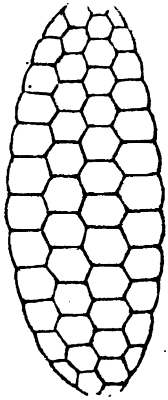

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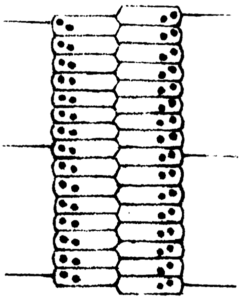

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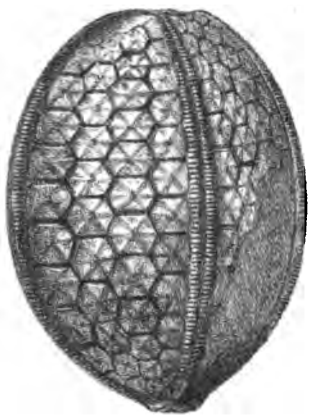

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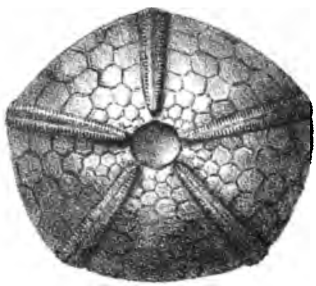

W. H. Baily del. et lith. Forster & Co. Impt. Dublin

TO ILLUSTRATE Mr WRIGHT'S & Mr BAILY'S PAPERS ON PALÆCHINUS

Palæchinus quadriserialis (Nov. sp.).

Elliptical; ventral and dorsal ends equal; interambulacra composed of two rows of pentagonal and two rows of hexagonal plates; two rows of pores on each side of the ambulacra; six to seven ambulacral plates, equal to the width of one of the lateral interambulacral ones. Length, two inches; width, 1½ inch.

This species may be known from *P. ellipticus*, the only one with which it can be confounded, by having four instead of five rows of interambulacral plates, differing in this respect from all previously described species, and even from the generic characters as laid down by M'Coy.

DESCRIPTION OF PLATE III.

Fig. 1, *a-c*, *Palæchinus quadriserialis*; *a*, side view, natural size; *b*, interambulacral plates, natural size; *c*, ambulacral plates, enlarged.

XIII.—On some New Points in the Structure of Palæchinus. By William Hellier Baily, F. G. S. & L. S.

[Read March 9, 1864.]

Having occasion to examine the important collection of fossils belonging to Sir Richard Griffith, Bart., which includes the examples of Palæchinus figured in the Synopsis of the Carboniferous Fossils of Ireland, I observed amongst them a slab from Hook Head, in the county of Wexford, upon the weathered surface of which three beautiful specimens of *P. elegans* were exhibited, although somewhat crushed. One of these still retained the plates of the *apical disc*, an important part of the *test* or shell which has, I believe, never before been described. (An exact representation of this fossil is given on Plate IV., Fig. A.)

The great difference between the Palæozoic Echinidæ and those of succeeding and more recent epochs consists in the much larger number of plates entering into the composition of the *test* in these ancient forms of Echini, the genus Palæchinus, so far as at present known, having from four to seven columns of *interambulacral* plates, whilst the Echini of the Secondary, Tertiary, and Recent periods are confined to two rows only.

It became, therefore, an interesting question to determine whether these Carboniferous examples of the group presented a corresponding difference in the arrangement or number of the plates of which the *apical disc* is composed. This I was enabled to decide by the discovery of these parts in the specimen before alluded to, which, although slightly displaced from their original position, were in sufficient preservation for that purpose.*

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* Since this Paper was written, I have, through the kindness of Mr. R. H. Scott, been enabled to examine a second specimen of this species from Hook Head, in the col-

After a careful examination, I found that in, accordance with the general characters of the order *Echinoidea*, the Palæchinus has five *genital* (*a*) and five *ocular* plates (*b*), making together ten plates to form the first or principal circle; the former perforated for the passage of the *ovarial* and *seminal canals*, the latter for the lodgment of the eyes. These plates, however, present the remarkable peculiarity of a *triple* perforation of each of the genital, and a *double* perforation of each ocular plate, suggesting an increase of the functions to which they were adapted corresponding with the large number of plates composing the test or shell of this ancient representative of the Echinoidea.

There are also two inner circles of plates surrounding the anal opening: those next the principal series (*c*), consisting of eight plates, correspond with what are called the *sur-anal*, in the *Saleniadæ* and some other more recent genera; the third circle is less complete; the number of plates composing it appears to be about ten, but, owing to displacement, they cannot be counted with certainty.

The principal plates differ in their proportions from those of the more recent examples of Echini, the genital plates being broader than long. What I presume to be the *madreporiform* plate, which should belong to this series, is unfortunately denuded of its surface, so that I could not ascertain the presence of the characteristic markings which usually distinguish it. The plate I believe it to be is rather larger than the others, as usually the case; all the other plates belonging to the two principal series are covered with granulations. A restored sketch of the apical disc, enlarged four diameters, is given on Plate IV., Fig. B.

An additional point of interest in the structure of this extinct genus is that of the discovery of spines, which I had observed some time previously on examining a fragment of one of these fossils, from the same locality, in the collection of the Geological Survey of Ireland. These spines are exceedingly minute, being rather less than the tenth of an inch in length, and on being submitted to microscopic examination were found to be longitudinally striated (a figure of one of them, enlarged twenty diameters, and a line to show the natural size, are represented at Fig. E); they are principally dispersed over the plates of the *ambulacra* and in its immediate neighbourhood, and were most probably the spines belonging to that series of plates.

On applying a magnifying power to one of the *interambulacral* plates, the mammillated or granulated appearance represented in the enlarged figure of a plate of this species in the Synopsis of Carboniferous Fossils of Ireland, Plate 24, Fig. 2 (*c*), resolved itself into distinct tubercles, *primary* and *secondary* (an intermediate plate of this character is drawn, enlarged eight diameters, at Fig. C). The larger or *primary* tubercles

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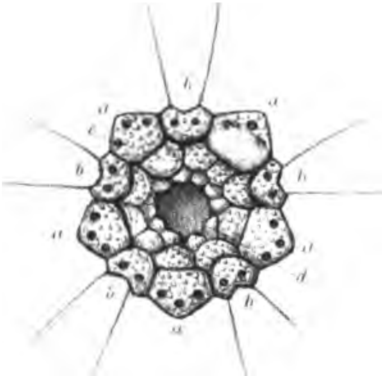
lection of the Royal Dublin Society, with the apical disc preserved, which, although not so clear in its details, retains more of its original position, and is so far satisfactory as to confirm my observations in that respect, founded upon the specimen in Sir Richard Griffith's collection.

B

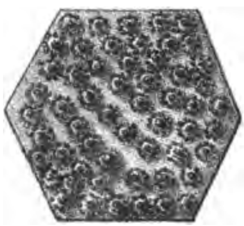


A

E

I

C



D

W. H. Baily del. et lith. Forster & Co. Impt. Dublin

TO ILLUSTRATE MR. BAILY'S PAPERS ON PALÆCHINUS

were seen to be distinctly perforated for the attachment of the spines, and surrounded by a circle of about ten smaller *secondary* ones (Fig. 5).

These additional details of structure go far to complete our knowledge of the shell or outer case of these ancient forms of Echini, which, although apparently furnished with a more complicated arrangement of parts, by the much larger number of elements composing it, will, I think, be found to exhibit merely a repetition of the same characters which prevail in their representatives at the present day.

XIV.—Some additional Notes on the Structure of Palæchinus. By William Hellier Baily, F. G. S. & L. S.

[Read April 12, 1865.]

Since my last communication to the Society on this subject, I have, through the kindness of Mr. Michael George Ryan, been enabled to examine an additional specimen of *Palæchinus ellipticus*, which he has liberally presented to the Geological Survey; that gentleman having been so fortunate as to knock out two examples of this rare fossil from a block of Limestone used in the construction of a drain at his then residence, Bettyville, near Croom, in the county of Limerick. As frequently happens, a very important part of the fossil was left behind in the Limestone in which it had been imbedded, the cast only having come out, divested of its shelly covering; this, however, may eventually be obtained, as he kindly promised to make inquiries, and if possible secure it for the Palæontological Collection in the Museum of Irish Industry.

Having all the examples at present known of this species intrusted to me for examination, I can safely say that this specimen, by its more complete condition, exhibits some additional particulars with regard to the structure of its test, and enables us on other points to confirm what before was merely conjectural.

In the first place I believe it presents us with good evidence of a mouth opposite to the apical disc, and corresponding with a similar arrangement of parts in recent Echini, as on this cast of the interior of the shell can be traced a termination of the plates in a slightly reflected edge, round an opening of about four lines in diameter; this part would no doubt be more clearly defined in the mould which represented the original shell.

Professor M'Coy, in his definition of the characters of this genus,* describes it as possessing a central mouth, and "ovarian plates as in Echinus:" this vague description, without any figures of the parts being given, has to a certain extent proved to be correct; for, although some important differences occur in the details of this apical or ovarian

* "Synopsis of the Carboniferous Fossils of Ireland," p. 171.

disc, the analogy is still very striking between these Palæozoic forms and the more recent examples of Echinidæ. He describes the plates to be covered with spiniform tubercles, *destitute of central ligament.* I find the tubercles and spines to be, however, distinctly perforated, indicating a ligamentary attachment, a fact which shows how necessary it is for observers to confine themselves to what they really see, instead of hazarding a statement as to the presence or absence of any character, on imperfect or even negative evidence.

Major Austin, in "The Geologist" for December, 1860, gives an outline figure of what appears to be one of the ambulacra of a species of Palæchinus, from the lower beds of the Carboniferous Limestone at Hook Head, in the county of Wexford. This fragment he considers to have belonged to a true Echinus, distinct from Palæchinus, and deems it to be of sufficient importance to form the type of a new genus, which he calls *Proto Echinus;* I regret that on a recent visit to the Hook I was unable to verify that gentleman's opinion as to its unique character, although so successful in that wonderful district for fossils as to meet with several examples of *P. elegans,* a species which is, I believe, confined to the lower or shaly beds of the Limestone. In the paper by Major Austin, to which I have referred, he also gives 'some observations on the genus Palæchinus,' in which he states that, "from specimens in his cabinet there was great reason to infer that the different species belonging to this genus possessed columns similar to the true Crinoids." This conjecture, for which I believe there is no real foundation, may have arisen from the specimen upon which Major Austin drew his conclusions having a portion of a Crinoid column lying in close contact with a Palæchinus; not at all an improbable occurrence. The arrangement of the apical disc, corresponding so generally with that of the Echini, shows them to have been more nearly related to the free Echinoderms, and would quite set aside the idea of their being stalked; in such a case the question might naturally be asked, Where, then, would the mouth be situated? The specimen for which we are indebted to Mr. Ryan assists considerably in confirming me in this opinion, as it appears to have a distinct oral termination at the opposite pole to that of the apical disc as in Echinus, an arrangement quite in accordance with its other structural peculiarities.

This Palæchinus also illustrates another very interesting fact, viz., that of the graduation or passage of one group into another, by the presence of some characters common to both, as shown by the ornamentation or strengthening of the plates composing the shell, which are seen to be covered by radiating ridges proceeding from their centres to each of the angles (Plate III., Fig. 2 *a*), presenting a very similar appearance to the markings which occur on the external surface of the plates of many of the *Cystidea,* and some of the Palæozoic Crinoids, such as *Glyptocrinus* and *Actinocrinus.*

I had hoped to have procured a sight of the second specimen in Mr. Ryan's possession before the meeting of the Society on this occasion, thinking it might, perhaps, have shown more clearly some of the pecu-

liarities of structure I have alluded to. Mr. Ryan, however, informed me that it was packed up at Limerick, with other articles, previous to his going abroad. At a future time, however, I hope to have an opportunity of examining it.

The specimen he has presented to the Survey agrees with that belonging to Mr. Joseph Wright, as far as can be seen, in having four rows of interambulacral plates only. I do not, however, consider their agreement in that respect as presenting sufficient grounds for making either it or Mr. Wright's specimen a new species, as that gentleman has thought it advisable to do; or as indicating anything more than a variety of *P. ellipticus*, to which it bears so close a resemblance in general form and other particulars; knowing also, from the specimens I have examined, how variable other species of the same genus are in that respect.

Explanation of the Plates.

Plate III., Fig. 2, *a*, *b*.—*Palæchinus ellipticus*, nat. size; Carboniferous Limestone; Bettyville, Co. Limerick.

(*a*). Side view, showing the plates covered by radiating ridges.
(*b*). End view, looking down upon apical disc.

Plate IV.—*Palæchinus elegans*; Lower Carboniferous Limestone; Hook Head, Co. Wexford.

Fig. A. Side view of crushed test, with apical disc, natural size.

B. Apical or genital disc, enlarged four diameters; (*a*) five genital plates; (*b*) five ocular plates; (*c*) eight sur-anal plates; (*d*) ten do., inner circle, incomplete.

C. One of the interambulacral plates, enlarged eight diameters, covered with tubercles for the attachment of the spines.

D. A primary tubercle, perforated, and surrounded by a circle of smaller or secondary tubercles, still more highly enlarged.

E. A spine, enlarged twenty diameters, striated, and having the base perforated for its ligamental attachment to the primary tubercles.

XV.—On a New Echinoderm from the Yellow Sandstone of Donegal. By William Harte, Esq., C. E.

[Read April 13, 1864.]

The fossil I now beg to lay before the Royal Geological Society of Ireland, and which I present to the Museum, I got lately near Lough Esk, about six miles from Donegal. The road along the western shore of the lake runs through Arenaceous Limestone; and on the left, going northwards, lies a bed of Limestone to which I shall have to refer again. This changes to Sandstone a little higher up; and through this the Board

of Works have partly made a road, in the cutting of which, just where it crosses the "Eglish" road, the fossil was found.

I now describe the shell, so far as defined by the fossil, which is a cast in a good state of preservation, the markings being, indeed, unusually sharp for one in Sandstone (Plate V.)

The shape is orbicular, depressed. The base is absent, and the cast seems to have yielded by pressure, and is spread out, somewhat of a bell-mouthed shape, though this has been effected with very little distortion or disarrangement of the plates.

The interambulacral spaces are composed at the lower extremity of the fossil of five rows of plates, and it is very probable they exceeded that number at the base. The two rows next the ambulacra are pentagonal, except the upper plates, which are nearly triangular.

The other three rows are hexagonal, very irregular, and nearly all become obsolete before reaching the anus. These hexagonal plates are almost smooth, or at least only marked by very minute tubercles, of which I think traces can be detected; but the genital and side pentagonal plates are very different.

The genital plates have each a large perforate tubercle, as in *Archæocidaris*, surrounded by a depressed ring, and this is again surrounded by a ring of about sixteen pores (Plate V., B.)

Of the rows next the ambulacra, the first plate (counting downwards from the apex), which is nearly triangular, has a small tubercle. The rest of the plates in this row are all pentagonal, as I have remarked. They increase in size downwards, as do also the tubercles.

The second plate has a large tubercle; this is surrounded by a depressed ring, and this again by a ring of very small tubercles.

The third plate is plain.

The fourth plate has a large tubercle, surrounded by the depressed ring and ring of tubercles, as in the second plate.

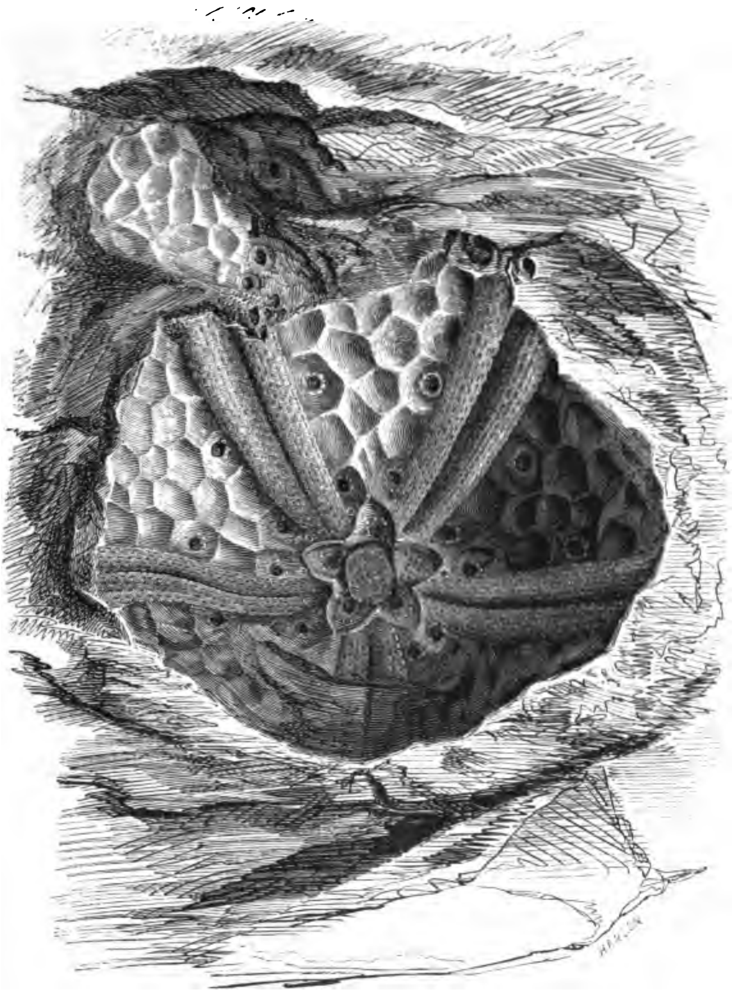
The fifth and sixth plates are plain, like the third.

The seventh plate is tubercled, and surrounded by the depressed ring and tubercles, as in the second and fourth plates.

The foregoing description applies to all the five interambulacral divisions, so that thus we have a series of concentric circles of tubercled plates in the pentagonal rows, at increasing distances from the anus down.

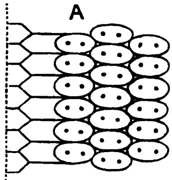
The ambulacra are large; the perforations are situated in two depressions; these perforations consist of three pairs of pores in each ambulacral depression (Plate V., A.) Four of the ambulacral plates equal in depth one of the pentagonal side plates. The dividing ridge shows the ambulacral plates well, having one small tubercle in each; a detached portion of either this same or another of these Echinoderms appears on the same stone, close to it, showing the plates of the ambulacra very distinctly.

There is no trace of any spines that I can see in this fossil. Unlike the fossils of *Archæocidaris*, to which I shall allude farther on, this Echinoderm was evidently rolled, or stripped of its spines, before being

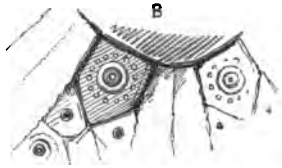


NATURAL SIZE.

A



B



A. Portion of ambulacral space, enlarged.

B. Genital and adjacent plates, enlarged.

TO ILLUSTRATE MR. HARTE'S PAPER ON A NEW ECHINODERM.

buried in the sand; but I have found in the same bed, and near the same place, a few detached plates of the animal, and I think the casts of some spines; and I also find traces of large plates in some of the very friable shales near it.

The fossils associated with this Echinoderm do not seem to be numerous, but I send a good specimen of *Psammodus porosus*, found in the same beds.

In the Limestone bed to which I have alluded, just under the Yellow Sandstone, I find a great number of fossils; but by far the most characteristic are those of *Archæocidaris*, which occur in the greatest profusion. They are found in groups of plates and spines; nearly all these groups present more or less the same assemblage of pentagonal and hexagonal plates, the latter tubercled, with numerous spines both smooth and muricated, giving the idea that each of these groups represent the remains of one or more of these animals as they there fell to pieces.

I exhibit several of these specimens. In no case do I find among them any pentagonal plates tubercled like those of the Sandstone fossil; and differing as it does from Palæchinus and Archæocidaris, I think there can be no doubt but that it is a new addition to the Echinoderms of the Carboniferous series.

XVI.—Report of Council.

[Read at the Anniversary Meeting, on Wednesday, February 8, 1865.]

In this, the first Annual Report of the Society, the Council cannot but congratulate the Fellows most heartily on the improved position of their body under its new title. The number of Fellows shows an increase of five above the number of members on the list of the Geological Society of Dublin on the 31st of January, 1864. Thirteen Fellows have been elected since that date, while the losses from various causes have amounted to nine. Five have been removed from the books for non-payment of subscriptions; one has resigned; and we have to lament the loss by death of three, Major-General Portlock, Dr. J. Kennedy Baillie, and Mr. J. E. Jackson.

Major-General Portlock was one of the original members of the Geological Society of Dublin; and a paper from his pen, "On the Study of Geology in Ireland," commences the "Journal" of the Society. He was at one time attached to the Ordnance Survey of Ireland, in which important service he spent nineteen of the most active years of his life, being on duty in Ireland from 1824 to 1843. The first operations in which he was engaged were those connected with the triangulation of the island, a duty which entailed at times prolonged residence under canvas at great heights above the sea, and which he successfully completed. It would hardly come within our limits to give a detailed account of his services in this department, and for this we must refer to the able memoir which was published by his friend, the present Under Secretary for Ireland.

When the Ordnance Survey was first established, it was intended to include in the duties of the officers of that department a full inquiry into the geology, natural history, and archæology of the districts surveyed, but the preliminary labours necessary for establishing the work on a proper footing engrossed the entire attention of the officers; and it was not until 1832 (to use the words of Major-General Larcom's memoir), that "it was proposed to compile at the head-quarters in Dublin a descriptive memoir, to be carried on in part by separate and special persons, and in part by the co-operation in the field of a new department at that time formed under Captain Dawson, an accomplished officer, for the execution of the general map—that is, the map on the one-inch scale, like the map of England, which was a sequel to the detailed survey from which its outline was to be reduced. In this effort, Portlock, having completed the great triangulation, was enabled also to co-operate, and undertook the geology and productive economy. He entered into it, as usual, with thorough earnestness. In his own words, after describing the original arrangements, and their suspension from the more urgent necessity for the maps, he says—'Geology, in fact, had been permitted, but not commanded;' and even when he was himself appointed to the charge, he 'had no power to enjoin a general geological inquiry.' In 1834, however, he was enabled to engage 'competent assistants in the various branches,' and in 1837 formed a geological and statistical office, a museum for geological and zoological specimens, and a laboratory for the examination of soils. It is only from this time that the Geological branch of the Irish Survey, in its enlarged form, can be said to have begun as an organized work."

In the prosecution of these duties he discovered and described, in 1837, the Trilobites and other fossils which occur in the neighbourhood of Pomeroy, county of Tyrone, and thereby established the identity of the strata containing them with the Lower Silurian beds of England and Wales, which had then been recently brought into notice by Sir R. Murchison and Professor Sedgwick. His work "On the Geology of Londonderry and of Parts of Tyrone and Fermanagh," remains the standard book on the subject, and is a monument of the clearness of description and the painstaking accuracy of observation for which its author was so deservedly remarkable.

The expense necessarily attending the publication of such a memoir as that originally contemplated was so great, that only one volume, entitled "Memoir of the City and North-western Liberties of Londonderry," was published; and in 1838 Portlock was ordered to draw his Geological work to a close, which he accordingly did, publishing in 1843 his work on the Geology of Londonderry, which we have before referred to. At this period his official connexion with the Survey ceased, and he returned to the ordinary duties of the corps of Royal Engineers.

The contributions made by General Portlock to our "Journal" were both numerous and important, extending over the first twenty years of the existence of the Society. He was President on two occasions for a period

of two years at each time, viz., in the years 1838–39, and 1851–52. His addresses were uniformly characterized by the exhaustive manner in which he discussed the broad principles on which our science is based, as well as the various discoveries which were from time to time brought before the geological public at the meetings of this Society and elsewhere.

General Portlock entered with great zeal into the development of other departments of natural history, and was one of the original founders of the Royal Zoological Society of Ireland, of which body he was at an early period elected to fill the presidential chair.

Dr. J. Kennedy Baillie was also for many years a member of the Geological Society of Dublin. He was at one time a Junior Fellow of Trinity College, and was appointed by the Board of the College to the rectory of Ardtrea. The branches of science in which he specially distinguished himself were classical philology and archæology. As regards the former, his two editions of the Iliad of Homer sufficiently attest his scholarship and ability, while he gave evidence of the latter by his Papers printed in the "Transactions of the Royal Irish Academy." He also published some "Lectures on the Philosophy of the Mosaic Record of Creation."

The Society has also to lament the loss of their late Assistant Secretary, Mr. George Blackwood. He had filled the office for a period of seven years, where his uniform attention to the special duties of his situation, and to the affairs of the Society in general, have rendered his loss one not easily replaced. Your Council have elected Mr. W. J. Galbraith to the vacant office, and they hope that this appointment will give satisfaction to the Society in general.

During the session which has just elapsed several papers of interest have been read at our meetings. In March we had two short papers on Granite, Mr. Medlicott sending us a notice of a thin granite vein which traverses limestone at Sungrumpoor, in India, and summing up the result of his investigation in the following words:—"The inevitable conclusion from all the circumstances appears to me to be, that this thin fibre of true Granite was introduced last of all, subsequent to the desiccation of the limestone, and by means of free solution, aqueous or vaporous, at a low temperature." Mr. Montgomery gave us a brief notice of a new locality for the occurrence of fragments of granite in limestone in the neighbourhood of Dublin.

The papers relating to Palæontology have presented several points of interest, especially as regards the structure of the Echinodermata of the Carboniferous formation. Mr. Joseph Wright of Cork, so well known for his researches among the Carboniferous fossils, laid before us a notice of a specimen of *Palæchinus ellipticus* from Midleton, county of Cork, which was remarkable for possessing only four rows of interambulacral plates. From this peculiarity its discoverer proposed to consider it as a variety of the ordinary structure of the species, and to name it *P. ellipticus var. quadriserialis.* This paper was followed by a very elaborate one by Mr. Baily "On some New Points in the Structure of

Palæchinus," which, as well as Mr. Wright's Paper, were illustrated by some beautifully executed drawings from the pencil of Mr. Baily. The chief points to which Mr. Baily drew attention were the structure and arrangement of the plates composing the apical disc, as compared with those of the recent Echinus, and also the minute spines which Mr. Baily noticed on a specimen of *P. elegans* from Hook Head, in the collection of the Geological Survey. These spines, although less than one-tenth inch in length, were found, when examined with the microscope, to be delicately striated.

Mr. Baily considered the peculiarity to which Mr. Wright had drawn attention in his paper to be a character hardly sufficient for a basis of specific distinction.

These papers were followed in April by a communication from Mr. Harte on a new Echinoderm from the Yellow Sandstone of Donegal, the same formation which has of late yielded so many interesting specimens to the same observer. The fossil in question, which was presented by its discoverer to the Society, proved to be a cast of the upper portion of a species resembling *Archæocidaris*, of which genus, previous to Mr. Harte's discovery, nothing but detached plates and spines had ever been discovered. The specimen was in very good preservation, and presented, among other peculiarities, the very interesting one, that while in the recent *Cidaridæ* all the plates are tubercled, in the specimen found by Mr. Harte the tubercles only appear on certain of the interambulacral plates, arranged in concentric circles round the apex as a centre. In May Mr. Macalister described a specimen of *Ulodendron* obtained by him near Glasgow, on which were exposed two different surfaces of the thin cortical lamella, exhibiting different markings, and illustrating the degree of caution which is necessary in describing new species.

Mr. Doyle gave an account of the discovery of *Knorria* in the Lower Carboniferous Limestone of the county of Kildare; and when the Society reassembled in November, after the vacation, Mr. John Kelly gave us a Paper "On the Doctrine of Characteristic Fossils," in which he expressed his opinion that this doctrine usually received more attention than it deserved, stating that the Silurian fossils in the neighbourhood of Galway do not occur in zones according to the age and succession of the different bands of rock. Mr. Kelly contended that part of the Devonian fossils is common to both the adjacent systems; and concluded his Paper by showing, from a list of the fossils stated by some writers to be characteristic of the Devonian System, that they occur in great numbers, on the one hand, in the Carboniferous Limestone, and on the other, in the Silurian strata.

In the branch of descriptive geology the papers presented some features of great interest. In May Mr. Close read a paper "On the General Glaciation of the Rocks in the Vicinity of Dublin," in which he described with great accuracy the directions of the striations and scratches which he observed on the rocks in this neighbourhood. He gave reasons for concluding that the agent was not floating, but land or glacier

ice. He also called attention to the ridging and furrowing of the country lying to the N. and N. W. of Dublin, showing that the directions of these ridges and of the rock-scorings coincide, and inferring therefrom that the current in the universal glacier, as it advanced from the W. N. W., divided near Maynooth, one portion turning sharply to the right, and flowing towards the W. S. W., while the other continued its course straight onwards. This latter ultimately swept round the northern end of the Dublin and Wicklow Mountains, assuming a course which became gradually more and more southerly, and conformed pretty nearly to the present coast line. He then showed that the stream flowed over the tops of Shankhill, Bray Head, and Little Sugar Loaf, the last-named summit being at an elevation of 1120 feet above the sea level. He attributed the rounding of the mountains to the denuding influence of the ice, and gave his reasons for showing that, besides affecting perceptibly the contours of several of the mountains, the ice had excavated the Scalp, Glen of the Downs, and some other gaps in the district. He showed how the effect of such an ice stream would be to carry the boulders from the Wicklow Granite towards the S. E., as is found to have been generally the case. Mr. Close's paper, with its accompanying map, leaves little to be desired as to the accuracy with which it records observations of natural phenomena, which are hardly noticeable to the unpractised eye.

On the same subject Mr. Ormsby gave a paper, being an account of the polished appearance presented by the surface of the limestone in certain places near Galway, which appears to have been produced by continued friction; while Mr. Foot recorded the removal of a large block of limestone to a distance of fifty yards in Lough Ree, by the action of ice, during the severe winter of 1855.

In June Mr. Harte brought under our notice some points relating to the physical features of the county of Donegal, more particularly relating to its history during the glacial period, to which much of the present striking scenery of the county is due. He first described the mountain ranges, and the different valleys and glens by which these are intersected, while in the lower ground along the shore of the Bay of Donegal we find hills of Yellow Sandstone and Arenaceous Limestone, all more or less ovate-shaped, the shorter slopes being next the mountains. These hills bear on their flanks the peculiar drift of the mountains towards which their major axes point: the traces of an ancient glacier still exist in the Gap of Barnesmore. Mr. Harte expressed his conviction that the eroding action of the ice had ceased when the land had attained its present elevation above the sea level, as the bottom of the Atlantic is proved by soundings to be perfectly level for a distance of some sixty miles off the coast. The extent of previous submergence must have been 1300 feet, at the least, for we find boulders lying at that level above the sea. Mr. Harte does not believe that any material alteration of level has taken place within a recent period, expressing his opinion that the so-called submerged forests had been originally growing

in lagoons, close to the sea level, and had never been actually submerged by subsequent sinking of the level of the land. The December meeting of the Society was occupied by a paper by Professor Haughton, giving an account of a recent visit paid by him to the islands of Mull and Skye, in which he gave us some interesting information relating to the Tertiary Leaf-beds of Ardtun Head, and the mineralogical constitution of the Syenite of Loch Scavaig in Skye, which he finds to be composed of Labradorite and Augite, and accordingly to form an additional link connecting the geology of the Metamorphic rocks of the west of Scotland with that of the Laurentian System of Canada.

In January we had a long and interesting discussion on the subject of gold and gold-diggings, which was introduced by a paper from Dr. W. Lauder Lindsay, "On the Geology of the New Zealand Gold-fields," followed by a description given by Mr. Sanders of the operations at present in progress in the Wicklow gold mine district under the direction of the Carysfort Mining Company. This question, as might be expected, gave rise to an animated conversation, which we may hope will not be the last on the same subject at our meetings.

A few words may be considered necessary to explain to those Fellows of the Society who may have been absent from the meetings which have been held since the vacation the present mode of electing the Fellows.

When it was announced in April last that the Society had been constituted the "Royal Geological Society of Ireland," a reference to the Council became necessary, in order to see whether any changes should be made in the bye-laws. A sub-committee was appointed, which presented to the Council a Report which was to the following effect:—

"That the Society be recommended in future,

"1. To change the £10 life composition into ten guineas;

"2. To change the £5 life composition into five guineas;

"3. To change the £1 and 10*s*. subscriptions into guinea and half-guinea subscriptions, and the £1 admission fee into one guinea;

"4. That the election of Fellows shall take place at the February meeting, with power to the Council to order a supplementary election at the June meeting;

"5. That not more than ten Fellows be elected at the February meeting, nor more than five at the supplementary election in June."

This Report was unanimously adopted at the meeting of the Society held on the 9th of November. These regulations will not in any way affect the existing Fellows. Any person who has entered the Society upon the understanding that he was to pay £1 a year will continue to enjoy that privilege; but any gentleman who shall be admitted after the passing of these resolutions will have to pay one guinea entrance fee, and one guinea subscription. The election to the Fellowship will take place only twice in each year, but undergraduates will be admitted as before, and no change will take place in the rate of their subscriptions. The part of the "Journal" which appeared in 1864 completed the tenth Volume of "The Journal of the Geological Society of

Dublin," and a general index to the whole ten volumes was included in it, so as to render the series as complete as possible. It is proposed to continue the "Journal" in the same form, commencing a new series with the session which has now been brought to a close.

As regards the financial position of the Society, the amount received during the past year has been £109 12*s.* 8*d.*, and the expenditure during the same period £60 5*s.* 3*d.* : however, this does not include the account for printing the last number of the "Journal," which was not sent in until the year had elapsed, and which with some other small accounts will leave a balance of about £50 still to be cleared off.

In the Appendix will be found, as usual :—

I. A List of Fellows now on the books of the Society.
II. ,, ,, gained and lost during the year.
III. ,, Donations received during the year.
IV. ,, Societies and Institutions to whom a copy of the Journal is regularly forwarded.
V. An abstract of the Treasurer's Account for the year 1864.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF FELLOWS, CORRECTED TO JANUARY 31, 1865.

Fellows are requested to correct errors in this List, by letter to the Hon. Secretaries, 35, Trinity College, Dublin; or to the Assistant Secretary.

OFFICERS OF THE SOCIETY FOR THE YEAR 1865-6.

PRESIDENT.—The Earl of Enniskillen, F. R. S.

VICE-PRESIDENTS.—Sir Richard Griffith, Bart., LL. D.; John Kelly, Esq.; Alex. Carte, M. D., F. L. S.; William Andrews, M. R. I. A.; Rev. H. Lloyd, D. D., F. R. S., Vice-Provost, T. C. D.

TREASURERS.—Gilbert Sanders, Esq.; F. J. Sidney, LL. D.

SECRETARIES.—Robert H. Scott, M. A.; Robert S. Reeves, M. A.

COUNCIL.—Rev. S. Haughton, M. D., F. R. S.; Robert Callwell, Esq.; Joseph B. Jukes, M.A., F. R. S.; John B. Doyle, Esq.; Alphonse Gages, M. R. I. A.; B. B. Stoney, C. E.; John Barker, M. D.; Samuel Downing, LL. D.; John Good, Esq.; W. B. Brownrigg, Esq.; Capt. Meadows Taylor, M. R. I. A.; W. Frazer, Esq.; E. H. Bennett, M. B.; Joseph Scott Moore, Esq.; A. Macalister, Esq.; with the Honorary Officers.

ASSISTANT SECRETARY.—Mr. W. J. Galbraith, 2, *Foster-place, Dublin.*

HONORARY FELLOWS.

Elected.	
1844.	1. Boué, M. Ami, For. Mem., L. G. S., *Paris.*
1861.	2. Daubrée, M., Membre de l'Institut, 91, *Rue de Gréville, St. Germains, Paris.*
1861.	3. Delesse, M., Ingénieur des Mines, *Paris.*
1861.	4. De Serres, M. Marcel, *Montpelier.*
1861.	5. Deville, M. C. Ste Claire, *Paris.*
1861.	6. Deville, M. H. Ste Claire, *Paris.*
1861.	7. De Koninck, M. L., For. Mem., L. G. S., *Liége.*
1861.	8. Geinitz, M. H. B., For. Mem., L. G. S., *Dresden.*
1863.	9. Hunt, Dr. T. Sterry, F. R. S., *Montreal.*
1844.	10. Lyell, Sir Charles, F. R. S., 53, *Harley-street, W., London.*
1861.	11. M'Clintock, Sir Leopold, R. N., 21, *Merrion-square, North.*
1844.	12. Murchison, Sir Roderick I., F. R. S., 16, *Belgrave-square, London, S. W.*
1832.	13. Sedgwick, Rev. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING FELLOWS.

1859.	1. Gordon, John, C. E., *India.*
1859.	2. Hargrave, Henry J. B., C. E., *India.*
1859.	3. Hime, John, C. E., *Ceylon.*
1858.	4. Kingsmill, Thomas W., *Hong Kong.*
1855.	5. Medlicott, Joseph, *India.*
1854.	6. Oldham, Thomas, F. R. S., *Calcutta.*

FELLOWS WHO HAVE PAID LIFE COMPOSITION.

1853.	1. Allen, Richard Purdy, 10, *Besboro'-terrace, N. C. Road.*
1861.	2. Armstrong, Andrew, 16, *D'Olier-street.*
1861.	3. Brown, Markham, *Connorree Mines, Ovoca.*
1857.	4. Carson, Rev. Joseph, D. D., F. T. C. D., *Trinity College.*
1861.	5. Connolly, J., *Kilmore, Artane.*
1832.	6. Davis, Charles, M. D., 33, *York-street.*
1857.	7. Dowse, Richard, *Mountjoy-square.*

Elected.
1861. 8. Fottrell, Edward, 86, *Harcourt-street.*
1862. 9. Frazer, W., M. D., 124, *Stephen's-green.*
1857. 10. Greene, John Ball, 6, *Ely-place.*
1857. 11. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1831. 12. Hamilton, Sir W. R., *Observatory, Dunsink.*
1848. 13. Haughton, Rev. Professor, M. D., F. R. S., 40, *Trinity College.*
1862. 14. Henry, F. H., *Lodge Park, Straffan, Co. Kildare.*
1850. 15. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1861. 16. Hone, Thomas, *Yapton, Monkstown.*
1831. 17. Hutton, Robert, F. G. S., *Putney Park, London.*
1851. 18. Jukes, Joseph Beete, F. R. S., 51, *Stephen's-green.*
1834. 19. King, Hon. James, M. R. I. A., *Mitchelstown.*
1856. 20. Lentaigne, John, M. D., *Great Denmark-street.*
1848. 21. Luby, Rev. Thomas, D. D., F. T. C. D., *Trinity College.*
1851. 22. Malahide, Lord Talbot de, F. R. S., *Malahide Castle, Malahide.*
1838. 23. Mallet, Robert, C. E., F. R. S., 1, *The Grove, Clapham-road, London.*
1846. 24. Murray, B. B., *County Survey Office, Downshire-road, Newry.*
1859. 25. Ogilby, William, F. G. S., *Liscleen, Dunmanagh, Co. Tyrone.*
1849. 26. Sidney, F. J., LL. D., 19, *Herbert-street.*
1864. 27. Symes, Richard Glascott, 51, *Stephen's-green.*
1851. 28. Whitty, John Irvine, LL. D., 2, *Frederick-street, S.*

FELLOWS WHO HAVE PAID HALF LIFE COMPOSITION.

1854. 1. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 2. Bryce, James, LL. D., F. G. S., *High School, Glasgow.*
1862. 3. Carter, T. S., *Watlington Park, Tetsworth.*
1855. 4. Clarke, Edward, M. D., 3, *Frankfort Buildings, Rathgar.*
1854. 5. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1857. 6. Crawford, Robert, C. E., *care of Messrs. Peto and Betts*, 9, *Great George's-street, Westminster, S. W.*
1861. 7. Crosbie, William, *Ardfert Abbey, Ardfert, Tralee.*
1861. 8. Dunally, Lord, *Kilboy, Nenagh.*
1856. 9. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 10. Dunraven, Earl of, F. R. S., *Adare, Co. Limerick.*
1836. 11. Enniskillen, Earl of, F. R. S., M. R. I. A., *Florence Court, Enniskille*
1844. 12. Esmonde, Sir Thomas, Bart., M. R. I. A., *Johnstown Castle, Wexford.*
1854. 13. Foot, Frederick J., 51, *Stephen's-green.*
1853. 14. Harkness, Professor, F. R. S., *Queen's College, Cork.*
1856. 15. Haughton, Lieut. John, R. A., *St. Helena.*
1857. 16. Haughton, John Hancock, Esq., *Carlow.*
1861. 17. Harte, W., C. E., *Rathmullen, Donegal.*
1850. 18. Head, Henry, M. D., 7, *Fitzwilliam-square.*
1858. 19. Hill, J., C. E., *Tullamore.*
1862. 20. Hudson, R., F. R. S., F. L. S., *Clapham Common, London.*
1839. 21. James, Sir H., Colonel, R.E., F.R.S., *Ordnance Survey Office, Southampton.*
1832. 22. Kearney, Thomas, *Pallasgreen, Co. Limerick.*
1857. 23. Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835. 24. Kelly, John, 51, *Stephen's-green.*
1853. 25. Kinahan, George H., 28, *D'Olier-street.*
1862. 26. Kincaid, Joseph, Jun., C. E., 9, *Spring-gardens, London, S. W.*
1838. 27. Larcom, Sir Thomas, R. E., LL. D., F. R. S., *Phœnix Park.*
1858. 28. Leech, Lieut.-Colonel, R. E., 3, *St. James's-square, London, S. W.*
1840. 29. Lindsay, Henry L., C. E., *Melbourne, care of J. Bower, Esq., C.E.*, 28, *South Frederick-street.*
1840. 30. Montgomery, James E., M. R. I. A.
1856. 31. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grinlay and Co.*, 3, *Cornhill, London.*

Elected.
1856. 32. Medlicott, Henry, F. G. S., *Roarkee, Bombay, per Smith and Elder, Cornhill, London, E. C.*
1857. 33. M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1845. 34. Neville, John, C. E., M. R. I. A., *Dundalk.*
1852. 35. O'Kelly, Joseph, 51, *Stephen's-green.*
1844. 36. Palmerston, Viscount, K.G., G.C.B., F.R.S., 4, *Carlton Gardens, London.*
1832. 37. Renny, Henry L., R. E., *Canada.*
1854. 38. Smyth, W. W., F. R. S., *Jermyn-street, London.*
1857. 39. Tait, Alexander, C. E., *Queen's Elms, Belfast.*
1832. 40. Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1864. 41. Waller, G. A., *St. James's-gate.*
1853. 42. Webster, William B., 104, *Grafton-street.*
1861. 43. Whitney, C. J., *Brisbane, Queensland.*
1846. 44. Willson, Walter, 51, *Stephen's-green.*
1854. 45. Wyley, Andrew, 51, *Stephen's-green.*
1857. 46. Wynne, Arthur B., F. G. S., 51, *Stephen's-green.*

ANNUAL FELLOWS.

1861. 1. Andrews, William, *The Hill, Monkstown.*
1831. 2. Apjohn, James, M. D., F. R. S., *South-hill House, Blackrock.*
1857. 3. Baily, W. H., F. G. S., 51, *Stephen's-green.*
1857. 4. Bandon, Earl of, D. C. L., *Castle Bernard, Bandon, Co. Cork.*
1859. 5. Barker, John, M. B., 64, *Waterloo-road.*
1861. 6. Barrington, C. E., *Fassaroe, Bray.*
1862. 7. Barrington, E., *Fassaroe, Bray.*
1855. 8. Barton, F., 2, *Grattan-street.*
1862. 9. Barton, H. M., 5, *Foster-place.*
1864. 10. Bateman, C. W., LL. B., *Swineford, Mayo.*
1859. 11. Battersby, Francis, M. D., *Warrington-place.*
1844. 12. Bective, Earl of, *Headfort, Kells.*
1862. 13. Bennett, E., M. B., 2, *Upper Fitzwilliam-street.*
1857. 14. Bolton, George, Jun., 6, *Ely-place.*
1861. 15. Bolton, H. E., *Westmoreland-street.*
1864. 16. Bradshaw, G. B., 20, *Hardwick-street.*
1831. 17. Brady, Right Hon. Maziere, Chancellor, 26, *Upper Pembroke-street.*
1861. 18. Brownrigg, W. B., 18, *Adelaide-road.*
1840. 19. Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857. 20. Carte, Alexander, A. M., M. D., F. L. S., *Royal Dublin Society.*
1862. 21. Close, Rev. Maxwell, *Newtownpark, Blackrock.*
1858. 22 Cotton, Charles P., C. E., 11, *Lower Pembroke-street.*
1862. 23. Cousins, A. L., *Strandville, Clontarf.*
1834. 24. Croker, Charles P., M. D., 7, *Merrion-square, West.*
1863. 25. Crook, Rev. R., LL. D., 6, *Seaview-terrace, Simmon's-court.*
1846. 26. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Usher-street.*
1853. 27. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1863. 28. Dixon, G., 10, *Burlington-road.*
1849. 29. Downing, Samuel, C. E., LL. D., 6, *Trinity College.*
1852. 30. Doyle, J. B., *The Mansion, Ballycastle.*
1857. 31. Frith, R. J., C. E., *Leinster-road, Rathmines.*
1858. 32. Gages, Alphonse, M. R. I. A., 51, *Stephen's-green.*
1864. 33. Gahan, A., C. E., *Omagh.*
1849. 34. Galbraith, Rev. Joseph A., F. T. C. D., *Trinity College.*
1864. 35. Garnett, A. C., 5, *Mountjoy-square, N.*
1859. 36. Green, Murdock, 52, *Lower Sackville-street.*
1862. 37. Gribbon, C. P., 72, *Stephen's-green.*
1831. 38. Griffith, Sir R., Bart., LL. D., F. G. S., 2, *Fitzwilliam-place.*
1856. 39. Good, John, *City-quay.*
1857. 40. Hampton, Thomas, C. E., 6, *Ely-place.*

Elected.
1861. 41. Hudson, A., M. D., *Merrion-square.*
1861. 42. Humphrey, H. T.
1861. 43. Hutton, E., M. D., 5, *Merrion-square, South.*
1834. 44. Hutton, Thomas, F. G. S., 116, *Summer-hill.*
1852. 45. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 9, *Trinity College.*
1842. 46. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1861. 47. Johnston, C. F., 9, *Eustace-street.*
1862. 48. Kinahan, G., J. P., *Roebuck-hill, Dundrum.*
1864. 49. Kinahan, Thomas, *Carlisle-buildings.*
1831. 50. Lloyd, Rev. Humphrey, D. D., F. R. S., S. F. T. C. D., 35, *Trinity College.*
1861. 51. Lyster, J., C. E., *Stillorgan Lodge, Stillorgan.*
1863. 52. Macalister, A., M. D., 10, *Gardiner's-place.*
1855. 53. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1861. 54. M'Comas, A., 23, *Rathmines-road.*
1851. 55. M'Donnell, John, M. D., 4, *Gardiner's-row.*
1852. 56. Mac Donnell, Rev. Richard, D. D., Provost of Trinity College, *Provost's House, Trinity College.*
1837. 57. Mollan, John, M. D., 8, *Fitzwilliam-square, North.*
1851. 58. M'Dowell, George, F. T. C. D., 6, *Trinity College.*
1859. 59. Moore, Joseph Scott, *The Manor, Kilbride, Co. Dublin.*
1862. 60. Moore, Stephenson C., *Kenilworth-villa, Rathmines.*
1831. 61. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 62. O'Brien, Octavius, 23, *Kildare-street.*
1863. 63. Ormsby, M. H., 16, *Fitzwilliam-square.*
1864. 64. Palmer, Sandford, *Roscrea.*
1857. 65. Porter, William, C. E., *Leinster Club, Leinster-street.*
1864. 66. Reynolds, Emerson J., *Booterstown, Co. Dublin.*
1861. 67. Ryan, George, 32, *Frederick-street.*
1857. 68. Reeves, R. S., 22, *Upper Mount-street.*
1861. 69. Roberts, W. G., *Ballinapark, Ovoca.*
1862. 70. Rowan, D. J., C. E., *Dundalk.*
1864. 71. Russell, H., *Simmon's-court.*
1852. 72. Smith, Robert, M. D., 63, *Eccles-street.*
1852. 73. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 74. Scott, Robert H., A. M., 41, *Wellington-place.*
1864. 75. Scovell, F., *Trafalgar-terrace, Monkstown.*
1859. 76. Stokes, William, M. D., F. R. S., 5, *Merrion-square, N.*
1861. 77. Stoney, Bindon, C. E., 65, *Wellington-road.*
1862. 78. Taylor, Captain Meadows, *Old-court, Harold's-cross.*
1864. 79. Tichbourne, C. R. C., *Apothecaries' Hall, Mary-street.*
1862. 80. Trench, W. R., *University Club, Stephen's-green.*
1859. 81. Waldron, L., M. P., LL. D., *Ballybrack, Dalkey.*
1859. 82. Walker, William F., A. M., 9, *Trinity College.*
1863. 83. Westropp, W. H. S., 2, *Idrone-terrace, Blackrock.*
1863. 84. Williams, R. P., 38, *Dame-street.*
1851. 85. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1864. 86. Wright, Joseph, 39, *Duncan-street, Cork.*

ASSOCIATES FOR THE YEAR.

1. Butler, F. A., *Leinster-square, Rathmines.*
2. Ellis, Robert H., *The Hill, Monkstown.*
3. Gore, J. E., 25, *Merrion-square, S.*
4. Wall, H. P., 16, *Trinity College.*
5. White, George, *Harrington-street.*

No. II.

LIST OF FELLOWS GAINED AND LOST,

DURING THE YEAR ENDING JANUARY 31, 1865.

FELLOWS GAINED.

Life.

1. Symes, R. Glascott, 51, *Stephen's-green.*

Half Life.

1. Waller, G. A., *St. James's-gate.*

Annual.

1. Bateman, C. W., LL. B., *Swineford, Co. Mayo.*
2. Bradshaw, G. B., 20, *Hardwick-street.*
3. Gahan, A., *Omagh.*
4. Garnett, G. C., 5, *Mountjoy-square, N.*
5. Kinahan, Thomas, *St. Kilda, Sandycove.*
6. Palmer, Sandford, *Roscrea.*
7. Reynolds, E. J., *Booterstown-avenue.*
8. Russell, H., *Simmons'-court.*
9. Scovell, Fielding, *Trafalgar-terrace, Monkstown.*
10. Tichbourne, C. R. C., *Apothecaries' Hall, Mary-street.*
11. Wright, Joseph, *Duncan-street, Cork.*

FELLOWS LOST.

Half Life.

1. Baillie, Rev. James Kennedy, D. D., *Stewartstown.* Deceased.
2. Portlock, Major-General, *Blackrock,* ditto.
3. Jackson, James, *Tulliderry, Blackwatertown,* ditto.

Annual.

1. Hone, Joseph, Jun., 35, *Lower Leeson-street.* Resigned.

Removed from List, for Non-payment of Subscription.

1. Blake, E. H., *Farmer's Club, Sackville-street.*
2. Ganley, Patrick, *Capel-street.*
3. Lisabe, F., C. E., 42, *Sackville-street.*
4. Stack, Rev. Thomas, F. T. C. D.
5. Wilde, Sir W. R., F. R. C. S. I., 1, *Merrion-square, N.*

State of the Society at the commencement of—

	Year 1864.	Year 1865.
Honorary Fellows,	13	13
Corresponding do.,	6	6
Life do.,	74	74
Annual do.,	82	86
	175	179

No. III.

DONATIONS RECEIVED TO JANUARY 31, 1865.

Amsterdam.—Kon. Akademie van Wetenschappen, Verslagen og Mededeelingen, Vols. XV., XVI. From the Academy.

——————— Jaarboek, 1857–62. From the Academy.

Berlin.—Zeitschrift für Allgemeine Erdkunde, Nos. 123–134. From the Geographical Society.

——— Zeitschrift der Deutschen Geologischen Gesellschaft, Vol. XV., Parts 2 and 4; and Vol. XVI., Parts 1 and 2. From the Society.

Bologna.—Accademia delle Scienze dell' Istituto Memorie, Tom. XII., and 2nd Series, Tom. I., II. From the Academy.

——————— Rendiconto delle Sessione, 1861–63. From the Academy.

Boston.—Proceedings of the Boston Natural History Society, Vol. IX., Sheets 12–20. From the Society.

——— Boston Journal of Natural History, Vol. VII., Part 4. From the Society.

——— Annual Report of the Museum of Comparative Zoology, 1863.

Brünn.—Verhandlungen des Naturforschenden Vereines, Vol. I. From the Association.

Brussels.—Annuaire de l'Academie Royale, 1864. From the Academy.

——— Bulletin de l'Academie Royale, 1863–64. From the Academy.

Caen.—Bulletin de la Société Linnéenne de Normandie, Vol. VIII. From the Society.

Calcutta.—Geological Survey of India, Annual Report, 1862–63, 1863–64. From the Director, Prof. Oldham.

——————— Memoirs, Vol. III., Part 2; Vol. IV., Part 2. From the same.

——— Palæontologia Indica, Vol. II., Part 6; Vol. III., Parts 1–5. From the same.

Copenhagen.—Oversigt over det K. Danske videnskabernes Selskabs Förhandlingar, 1862–63. From the Academy.

Dresden.—Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, 1863. From the Society.

Dublin.—The Dublin Quarterly Journal of Science, Nos. 14–16. From the Editor, the Rev. Samuel Haughton, M. D.

——— Journal of the Royal Dublin Society, No. 31. From the Society.

——— Proceedings of the Royal Irish Academy, Vol. VIII., Part 7. From the Academy.

——— Transactions of the Natural History Society of Dublin, Vol. II., Part 3; Vol. III., Parts 1, 2. From the Society.

——— Explanations to Sheets 184, 187, 195, 196 of the Geological Survey of Ireland. From Sir R. Murchison, Director-General.

Edinburgh.—Transactions of the Royal Scottish Society of Arts, Vol. VI., Part 4. From the Society.

Kilkenny.—Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society. Nos. 42–44. From the Society.

Königsberg.—Schriften der K. Physikalisch-Œkonomischen Gesellschaft, 1863, I., II. From the Society.

Leeds.—Annual Report of the Philosophical and Literary Society for 1863–64. From the Society.

——— Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire for 1863–64. From the Society.

Leipsic.—Berichte über die Verhandlungen der Königlichen Sächsischen Gesellschaft der Wissenschaften, 1863, Parts 1, 2. From the Society.

——— Darlegung der theoretischen Berechnung der in den Mond-tafeln angewandten Störungen. II. By P. A. Hansen. From the same.

——— Elektrodynamische Maassbestimmungen. By W. Weber. From the same.

Liverpool.—Transactions of the Historic Society of Lancashire and Cheshire, Vol. XV. From the Society.

Liverpool.—Proceedings of the Literary and Philosophical Society, No. 17. From the Society.

——— Proceedings of the Liverpool Geological Society, Sessions 1–5. From the Society.

London.—Quarterly Journal of the Geological Society, Nos. 78–80. From the Society.

——— Proceedings of the Royal Geographical Society, Vol. VIII., Parts 1–6; Vol. IX., Part 1. From the Society.

——— Journal of the Royal Geographical Society, Vol. XXXIII. From the Society.

——— Notices of the Proceedings of the Royal Institution of Great Britain, Vol. IV., Parts 3, 4. From the Institution.

——— Proceedings of the Royal Society, Nos. 60–69. From the Society.

——— Report of the British Association, Newcastle-upon-Tyne, 1863. From the Association.

——— Journal of the Proceedings of the Linnæan Society, Vol. VII., Part 28; Vol. VIII., Parts 29–31. From the Society.

——— The Mining and Smelting Magazine, Nos. 27–37. From the Editor.

——— Proceedings of the Zoological Society, 1863, Parts 1–3. From the Society.

——— Proceedings of the Geologists' Association, 1863–64. From the Association.

——— Journal of the Geologists' Association, 1864. From the same.

Madrid.—Memorias de la R. Academia di Ciencias, Ciencias Exactas, Vol. I., Parts 2, 3; Vol. II., Part 1. From the Academy.

——— Resumen de las Actas, &c., de la R. Academia, 1861–62. From the same.

——— Libros del Saber de Astronomia del Rey Alfonso de Castilla, Vols. I., II. From the same.

Manchester.—Transactions of the Manchester Geological Society, Vol. IV., Part 13. From the Society.

Milan.—Atti del Reale Istituto Lombardo de Scienze, Vol. III., Parts 5–8, 15–20. From the Institute.

Montreal.—The Canadian Naturalist and Geologist, and Proceedings of the Natural History Society of Montreal, New Series, Vol. I., Part 4. From the Society.

Munich.—Sitzungs-berichte der K. Baierischen Akad. der Wissenschaften zu München, 1863, Vol. II., Parts 2–4; 1864, Vol. I., Parts 1–5; Vol. II., Part 1. From the Academy.

Neuchatel.—Bulletin de la Société des Sciences Naturelles, Vol. VI., Parts 2, 3. From the Society.

Newhavén.—The American Journal of Science and Art, Nos. 109–113. From the Editors.

Philadelphia.—Proceedings of the Academy of Natural Sciences, Parts 1–7, 1862. From the Academy.

——— Proceedings of the American Philosophical Society, Vol. IX., No. 70. From the Society.

Plymouth.—Report of the Transactions of the Plymouth Institution, 1863–64. From the Institution.

Quebec.—Transactions of the Literary and Historical Society, 1863–64. From the Society.

Stockholm.—Ofversigt af K. Vetenskaps Akademiens Förhandlingar, 1863, Nos. 1–10. From the Academy.

Toronto.—The Canadian Journal of Industry, Science, and Art, Nos. 49–54. From the Canadian Institute.

——— Report of the Geological Survey of Canada up to 1863. From the Governor-General, Viscount Monck.

Truro.—Journal of the Royal Institution of Cornwall, No. I., March, 1864. From the Institution.

Vienna.—Jahrbuch der K. K. Geologischen Reichsanstalt, Vol. XIV., Part 1. From the Editor, Prof. Haidinger.

Washington.—Report of the Smithsonian Institution for 1862. From the Institution.

Zurich.—Vierteljahres-schrift der Naturforschenden Gesellschaft, 1861–63. From the Society.

PRESENTED BY THE AUTHORS.

Binney (E. W., F. R. S.)—Further Observations on the Carboniferous Strata of Cumberland and Dumfries.
——— (W. G.)—Bibliography of North American Conchology.
Blomstrand (C. W.)—Geognostiska Jakttagelser under en Resa till Spetsbergen in 1861.
Delesse (M.)—Sur la Machoire Humaine de Moulin Quignon.
Dickinson (J., F. G. S.)—On Modern and Scriptural Geology.
Eggleston (T.)—Catalogue of Minerals.
Forchhammer (Prof. G.)—Ueber die Ahlbildung in Dänemark, und den Campin Sand in Belgien.
——— Die Juraformationen i det nordlige Jylland.
——— Om Vandforende Lag i Almindelighed.
——— Om Leiringsforholdene og Sammensœtningen af det nyere kridt i Danmark.
Hull (E., F. G. S.)—On the New Red Sandstone and Permian Formations as Sources of Water Supply.
Kinahan (G. H., M. R. I. A.)—On Crannoges in Loughrea.
——— On the Eskers of the Central Plain of Ireland.
Morton (G. H., F. G. S.)—The Geology of the Country around Liverpool.
Nordenskiold (A. E.)—Geologisk och Geognostisk Beskrifning öfver Spetsbergen.
Oldham (Thos., F. R. S.)—Memorandum of the Results of a Cursory Examination of the Salt Range in the Punjab and in Parts of Burnoo and Kohat.
Ramsay (Prof. A. C.)—Address, Geological Society of London, Feb. 19, 1864.
Sharswood (Dr. W.)—Catalogue of Minerals containing Cerium.
Winchel.—(A., State Geologist for Michigan), First Report of the Progress of the Geological Survey of Michigan.
——— Description of Fossils from the Yellow Sandstone of Burlington, Iowa.
——— " " from the Potsdam Sandstone.
——— " " from the Marshall and Huron Groups of Michigan.
——— On the Saliferous Rocks of Michigan.
——— On the Salt Manufacture of the Saginau Valley, Michigan.
——— Description of Elephantine Molars in the Museum of the University.
Wright (Thomas, M. A.), on the Early History of Leeds, in Yorkshire.

No. IV.

SOCIETIES AND INSTITUTIONS TO WHOM THE JOURNAL OF THE ROYAL GEOLOGICAL SOCIETY OF IRELAND IS SENT.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
ANTWERP, .	Société Palæontologique de Belgique.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geographical Society.
	German Geological Society, per Besserche Buchhandlung, *Behrenstr 7, Berlin.*
BOLOGNA, .	Academia della Scienze dell' Istituto.
BORDEAUX, .	Imperial Academy of Sciences.
BOSTON, . .	American Academy.
	Natural History Society.
BRISTOL, . .	Institution for the Advancement of Science, Literature, and the Arts.
BRÜNN, . .	Naturforschende Verein.
BRUSSELS, .	Academy of Sciences.

CAEN, . . . Société Linnéenne de Normandie.
CALCUTTA, . Asiatic Society.
Public Library.
Geological Survey of India.
CAMBRIDGE, . Philosophical Society.
University Library.
COPENHAGEN, Royal Society of Science.
CORK, . . . Queen's College Library.
Royal Institution.
DIJON, . . . Academy of Sciences.
DRESDEN, . . The "Isis" Society.
DUBLIN, . . Royal College of Surgeons' Library.
Royal Irish Academy.
University Library.
Royal Dublin Society.
Natural History Society.
Ordnance Survey Library.
Professor Sullivan, as Editor of the "Atlantis."
Geological Survey of Ireland.
Institution of Civil Engineers.
EDINBURGH, . Royal Society.
Wernerian Society.
Royal Scottish Society of Arts.
University Library.
Society of Antiquaries.
Advocates' Library.
FALMOUTH, . Royal Cornwall Polytechnic Society.
FLORENCE, . Society of Physics and Natural History.
GALWAY, . . Queen's College Library.
GENOA, . . Society of Physics.
GLASGOW, . . University.
GÖTTINGEN, . University.
HALLE, . . Natur-forschende Gesellschaft.
HANAU, . . Oberhessische Gesellschaft der Natur-und Heil-kunde.
HANOVER, . Royal Library.
KILKENNY, . Archæological Society.
KÖNIGSBERG, Königlich Physikalisch-Oekonomische Gesellschaft.
LAUSANNE, . Société Vaudoise des Sciences Naturelles.
LEEDS, . . Geological and Polytechnic Society of the West Riding of Yorkshire.
Philosophical and Literary Society.
LEIPZIC, . . Royal Society of Sciences (Saxony).
University.
LIVERPOOL, . The Literary and Philosophical Society.
Historic Society of Lancashire and Cheshire.
Geological Society, The Royal Institution, *Colquitt-street.*
LONDON, . . Geological Survey, *Jermyn-street.*
British Museum.
Society of Arts, *John-street, Adelphi.*
Royal Institution, *Albemarle-street.*
Royal Society, *Burlington House.*
Geological Society, *Somerset House.*
Linnean Society, *Burlington House.*
Royal Geographical Society, 15, *Whitehall-place.*
Civil Engineers, Institution of, 25, *Great George's-street, Westminster.*
Royal Asiatic Society, 5, *New Burlington-street.*
Royal College of Surgeons, *Lincoln's Inn.*
Zoological Society, 11, *Hanover-square.*
Athenæum, 14, *Wellington-street, Strand, W. C.*

LONDON, . .	Anthropological Society, 4, *St. Martin's-place, W. C.*
	Mining and Smelting Magazine, 36, *Cannon-street, E. C.*
LYONS, . .	La Société Impériale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
	Société Linnéenne.
	Academie Impériale.
MADRID, . .	Academia de Ciencias.
MANCHESTER,	Literary and Philosophical Society of. [Sec., R. C. Christie.]
	Geological Society.
MELBOURNE, .	Philosophical Institute of Victoria.
MILAN, . .	Reale Istituto Lombardo di Scienzi.
MISSOURI, . .	State Survey and University, *Geological Rooms, Columbia, U. S. A.*
MODENA, . .	Imperial Institute of Science.
MONTREAL, .	Natural History Society.
MUNICH, . .	Royal Academy of Science (2 copies).
NEUCHATEL, .	Société des Sciences Naturelles.
NEWHAVEN, .	The Editors of Silliman's Journal of Science and Art.
OXFORD, . .	Bodleian Library.
	Ashmolean Society.
PARIS, . .	Ecole Polytechnique.
	Geological Society.
	L'Ecole Impériale des Mines.
	Institute of France.
	Bibliothéque Impériale.
	Jardin des Plantes, Bibliothéque.
PHILADELPHIA,	American Philosophical Society.
	Academy of Natural Sciences, per Trübner and Co.
PLYMOUTH, .	Plymouth Institution and Devon and Cornwall Natural History Society.
PRESBURG, .	Verein für Naturkunde.
QUEBEC, . .	Literary and Historical Society.
ROME, . . .	The Vatican Library.
ROUEN, . .	Academy of Science.
ST. ANDREWS,	University Library.
ST. LOUIS, . .	Academy of Sciences.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
	Russisch-Kaiserliche Mineralogische Gesellschaft.
STOCKHOLM, .	Royal Academy of Science, per Longman and Co., *Paternoster-row, London*; and Sampson and Wallis, *Stockholm.*
STRASBOURG, .	Société des Sciences Naturelles.
STUTTGART, .	Verein für vaterländische Naturkunde.
TORONTO, C.W.,	Canadian Institute, per Thomas Henning, Esq.
TOULOUSE, .	Academy of Sciences.
TRURO, . .	Royal Institution of Cornwall.
TURIN, . .	Royal Academy.
UPSALA, . .	Royal Society of Sciences.
VIENNA, . .	Imperial Academy of Sciences.
	Prof. W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichs-anstalt."
WASHINGTON,	Smithsonian Institute Library, per W. Wesley, Esq., 2, *Queen's Head Passage, Paternoster-row, London, E. C.*
WINDSOR, .	The Royal Library.
ZURICH, . .	Naturforschende Gesellschaft.

No. V.

ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1864.

1864. Dr.		£ s. d.
To Balance from last year's Account,		16 19 4
— Amount of Subscriptions received for year ending December 31, 1864, viz.—		
— Life Compositions,	£10 0 0	
— Entrance Fees,	14 0 0	
— Annual Subscriptions,	72 12 0	
		96 12 0
— Amount of Dividend for one year on Government Stock,		3 0 8
		£116 12 0

1864. Cr.		£ s. d.
By Assistant Secretary, Half-year's Salary, to June 30, 1864,		10 0 0
— Mr. Cavenagh, for Binding,	£1 16 6	
— Messrs. Foster and Co., for Engraving,	2 9 0	
— Mr. W. Oldham, for Woodcuts,	5 10 0	
— Messrs. Williams and Norgate, for Carriage,	1 4 6	
		11 0 0
— Porter's Wages,	7 17 6	
— Gratuity to Attendant,	1 10 0	
— Mr. Oldham, for Woodcuts,	2 0 0	
— Messrs. Williams and Norgate,	4 16 4	
— Mr. Tallon's Account for Stationery,	2 5 6	
— Sundries (as per Book),	11 13 7	
		30 2 11
— Porter's Wages,	6 12 6	
— Carriage of Parcels,	0 8 6	
— Palæontographical Society (Subscription),	3 3 0	
— Sundries (as per Book),	8 18 4	
		19 2 4
— Balance in Bank,	37 19 4	
— Cash in hands,	8 7 5	
		46 6 9
		£116 12 0

We have examined the foregoing Account, and compared vouchers, and find that a balance remains to the credit of the Society of £46 6*s*. 9*d*.

(Signed) ROBERT CALLWELL.
B. B. STONEY.

Audited February 1, 1865.

MINUTES OF PROCEEDINGS FOR THE YEAR 1864-65.

MARCH 9, 1864.

GILBERT SANDERS, Esq., in the Chair.

The minutes of last Meeting were read, compared, and signed. Donations were announced, and thanks voted.

The following gentlemen were elected Members of the Society:—Emerson J. Reynolds, Esq., Booterstown; Fielding Scovell, Esq., Trafalgar-terrace, Monkstown; George C. Garnett, Esq.. 5, Mountjoy-square, North; Joseph Wright, Esq., 39, Duncan-street, Cork.

The Rev. Dr. Haughton brought forward a letter and specimens from J. B. Medlicott, Esq., illustrative of the mode of formation of Granite veins at Sungrumpoor, in India:—

"1, *Hastings-street, Calcutta*, 21*st May*, 1863.

"MY DEAR SIR,—The specimen that I mentioned to you in my last goes by this mail. If there be any who can still doubt the great influence of water in the production of granitic rocks, this example must, I think, decide them. I have never seen or heard of so strong a case of evidence for this mode of action: it will not fail to interest you. The specimen, which is about 1·5 inches thick, shows the entire width of a thin irregular vein, one side being only slightly reduced by weathering. The great part of the mass is a dense limestone. A well-marked plane parallel to the flat sides, *i. e.* to the walls of the vein, divides the whole piece into two nearly equal portions. A slight gaping has occurred along this crack, as it might be from the shrinkage of the two sides of Limestone, and the interstices so occasioned are now filled by Granite, of fine grain and well compacted texture. I cannot pretend to say to what exact species or varieties the constituent minerals belong; it is easy, however, to detect the shining facets of pink feldspar, the dark mica, and the quartz. The rock is in fact such as, according to our old notions, we should have looked upon as of a decidedly intrusive type.

"The main part of the evidence lies, of course, in the *gisement* of the vein. You will find this described at p. 17, vol. ii., of the 'Memoirs of Geological Survey, India.' The sketch there given will at least help you. It represents a junction of perfectly undisturbed sedimentary rocks upon a denuded surface of crystalline rocks. Large angular *débris* of the latter is strewn over the contact surface. The bottom 15 feet of the overlying rocks is of a very nondescript character. Its chief component is limestone of the same kind as that in the specimen. Through this are numerous strings and discontinuous layers of finer granitic and trappean *débris* in various states of modification. The covering rock is flaggy sandstone. There is no approach to what is understood as metamorphism in these beds, and they are equally free from disturbance, the usual concomitant of metamorphism.

"The condition of the crystalline rocks themselves is equally favourable to our case. Though thoroughly crystalline, they are not amorphous in the mass. Within the small span represented in the sketch there are several well-marked varieties, and that observe a roughly bedded relation among themselves. None of these varieties are like that in the specimen.

We now come to the vein. As represented in the drawing, it appears to be isolated among the crystalline rocks. The connexion that I have no doubt once existed with the ancient surface of denudation was in the portion removed by recent weathering. The evidence for this free connexion rests not only upon the identity of the chief veinstone with the covering rock, but also upon the frequent occurrence of rolled pebbles and grains in the vein. The whole, as it now exists, is probably a pseudomorph of a vein most likely of quartz, connate with the metamorphism of the lower rocks.

"The inevitable conclusion from all these circumstances seems to me to be, that this thin fibre of true Granite was introduced last of all, subsequent to the desiccation of the limestone, and by means of free solution, aqueous or vaporous, at a low temperature.

Igneo-aqueous plasticity is out of the question; the recognizable granite is in planes not more than the one-twentieth of an inch in the vein. Igneous fluidity is utterly impossible. The only supposition by which the correctness of my conclusion can be gainsayed is that this granite is the remnant of the original substance of the vein, and of which the limestone is now the pseudomorph.

"A slight inspection of the specimen removes this doubt. The sharply defined separation of the Granite and the Limestone shows plainly that there was a free surface of the limestone before the existence of the Granite."

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Professor Haughton would only add that the thin plate of Granite in the specimen was as true Granite as if it had been a mile thick, and was evidently not produced by igneous action.

Mr. A. Montgomery read a notice of a new locality for the occurrence of Granite in limestone, near Rathfarnham (p. 15).

The Chairman said, such specimens of Granite were not uncommon at Donnybrook, he himself had obtained a good many specimens from that quarter, some of them very large. The Granite found there manifested a curious tendency to decompose, or "slack," on exposure to the air, in the manner Mr. Montgomery had described. He had seen large lumps of many pounds' weight become so soft that they would crush under the pressure of the foot.

Mr. Scott observed that on the walls along the Floraville-road, from Donnybrook, several specimens of Limestone were to be found, containing not only Granite, but Mica Slate in lumps, disseminated through them. He believed that the quarry from which these had been taken was now worked out.

The Chairman said that he had a large specimen, obtained from thence about six months ago.

Mr. Ormsby said that an essential constituent of this Granite which occurred in the Limestone was kaolin from the decomposed feldspar, and also that the mass was saturated with carbonate of lime, so that it effervesced when treated with acid. He thought an easy way of accounting for its decomposition was thereby afforded. He brought home a specimen of the Granite, from which he washed off a quantity of China clay; and on leaving it for a while, it became again covered with a quantity of the same substance. He accounted for this by supposing that the feldspar, while in a partial state of decomposition, absorbed a quantity of water from the atmosphere, became a hydrated silicate of alumina, and burst. The theory of Mr. Sterry Hunt as to the decomposition of Granite, mentioned in his paper read last April, seemed particularly applicable to this sort of Granite, which was so much exposed to the action of carbonate of lime in solution in water containing free carbonic acid.

The Secretary read a Letter from Professor Phillips, of Oxford, giving an account of some Granites of which he had sent specimens to the Museum of Trinity College. Among these was the Granite of Shap Fell, which was remarkable for the fact of its being generally distributed in boulders over the country, while the mass of the rock found *in situ* in the hill was only insignificant. The Granite was characterized by the presence of iron pyrites in it.

The Chairman remarked that the fact of the existence of minerals, such as iron pyrites, which were decomposed by an elevated temperature, in Granite, had always been to his mind an insuperable objection to the supposition of the igneous origin of Granite.

Mr. Scott then read a paper by Mr. Joseph Wright, of Cork, "On a *Palæchinus* from the Carboniferous Limestone of Midleton, county of Cork" (p. 62).

Mr. Baily, F. G. S., described the drawing of the specimen referred to by Mr. Wright, which was represented on the diagram illustrating his own paper, and then read his own paper "On Some New Points in the Structure of *Palæchinus*" (p. 63). In allusion to Mr. Joseph Wright's paper on a variety of *Palæchinus ellipticus*, Mr. Baily remarked that he did not consider the number of the columns of interambulacral plates sufficient for specific distinction, as he found certain species presenting a variation in that respect; for instance, the type specimen of *Palæchinus elegans*, described and figured

by Professor M'Coy, has five rows of interambulacral plates, whilst specimens of the same species in the Geological Survey collections have four rows only. An irregularity also occurs in the arrangement and number of the plates in the magnificent specimen of *P. sphæricus*, also noticed by Professor M'Coy, which was kindly lent for exhibition at the meeting by the Rev. Mr. Fox, to whom it belongs. Mr. Baily, after giving an account of the leading characteristics of the order Echinoidea, in which the genus *Palæchinus* is included, alluded to the differences between the Palæozoic Echinidæ and those of the more recent deposits and living forms, which he stated to consist in the presence of a much greater number of plates composing the test or shell, with other corresponding differences in the details of its structure. He described *Palæchinus* as having a range of from four to seven columns of the larger or interambulacral plates, whilst the Echini of succeeding periods and those at present living are confined to two columns only. Of the allied genus *Archæocidaris*, which, like *Palæchinus*, is for the most part confined to Carboniferous strata, only detached plates and spines have hitherto been met with, their pentagonal form indicating that this fossil urchin, like the *Palæchinus*, differed from more recent examples of the group in the increased number of plates composing its shell. In other respects it resembles the recent *Cidaris*; and as we see in *Palæchinus* the representative of the *Echinus* of the present day, so *Archæocidaris* may be considered to be the prototype of *Cidaris*. We have here, however, no proof of degeneration in the more complicated and elaborate arrangement of parts entering into the composition of these ancient Echinoderms, but, on the contrary, evidence of a higher organization than prevails in any of the group from that period down to the present day. The discovery of the plates comprising the apical disc was made by Mr. Baily on his examination of the fine series of *Palæchinus* in Sir Richard Griffith's collection.

Mr. Scott said that they were very much obliged to Mr. Wright, who, he was glad to say, had been elected a member on that evening, for having taken the trouble of coming up from Cork to lay this paper before them. It was very rare to meet so perfect a specimen of this fossil as that which Mr. Wright had discovered. As to the specimen of *P. sphæricus* to which Mr. Baily had referred, they were indebted, as Mr. Baily had said, to the kindness of the Rev. S. W. Fox, who, as was well known, had had it in his possession for many years, and valued it very highly, as it deserved. The Society ought, therefore, to be very grateful to him for lending it to them. It was supposed to have been obtained from the Limestone of the county of Kildare, but that was not certain.

Mr. Wright said, he was not all sure that the specimens which had only four rows of plates were of the same species with those that exhibited five rows. In recent *Echini* they only saw two rows. One large species of *Palæchinus* represented in the drawing showed six rows, and another seven rows. But those that had seven rows showed great irregularity in the arrangement, the number of bands on each side being unequal. There was the same irregularity in the specimen belonging to the Museum of Irish Industry.

Mr. J. B. Doyle read a Paper "On the Occurrence of *Knorria imbricata* in the Lower Limestone of Kildare" (p. 13).

Mr. Baily stated that he believed the fine fossil plant which formed the subject of Mr Doyle's paper was *Knorria imbricata*, described by Continental fossil botanists as *Sagenaria*; its occurrence in the same quarry with the large bivalve shell, correctly identified by Mr. Doyle as *Cyprina Egertoni*, was good evidence as to its being from Carboniferous Limestone. Fossil plants similar to that brought before the notice of the meeting by Mr. Doyle had been collected by the Geological Survey from the upper beds of the Old Red Sandstone, and the Lower Carboniferous Shales and Sandstones. Its occurrence in the Limestone had not, he believed, been before observed.

The meeting then adjourned.

APRIL 13, 1864.

The PRESIDENT in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

The President announced that, as the change in the constitution of the Society which was announced on the notice paper for the evening might necessitate some slight change in the by-laws, he would request that any gentleman who had candidates to propose for the honour of Fellowship of the Society would mention their names, so that they might be balloted for at the next meeting.

The following names were then proposed:—A. Gahan, Esq., C. E.; H. Russell, Esq.; R. T. Brabazon, Esq.; R. Glascott Symes, Esq.; and Sandford Palmer, Esq. R. H. Ellis, Esq., was proposed as an Associate.

The President then called on Mr. Scott to read the Report from Council (p. 1).

Mr. Ormsby then read his paper on "A Polished and Striated Surface in the Limestone of Ross Hill, county of Galway" (p. 18).

Mr. Jukes said that the Society was indebted to Mr. Ormsby for the care with which he had investigated the subject, to which his own attention had been drawn by Mr. Ormsby in the course of last winter. He had lately visited the locality himself, and he could only say that the phenomenon was much more striking on a large scale than could be supposed from the inspection of a hand specimen. Surfaces fifty or sixty yards in length were laid bare, quite smooth, and dipping at a uniform angle of about half a degree. These smooth surfaces had been covered with clay, and their appearance was very different from that of surfaces which had been long exposed, showing how the erosive action of the air destroyed the markings of the direct action of ice. He (Mr. Jukes) did not know whether the polish was supposed to be produced by ice itself or by the clay beneath moving ice—an agency which would seem to him to have been necessary. At all events, from the gently undulating character of the country, it would seem that the ice did not belong to local glaciers, but more probably to a large sheet covering the whole surface of the district. In connexion with this subject, he would mention that his friend, Dr. Melville, of Galway, had expressed the opinion that in the neighbourhood of that town they had the true "boulder clay" of Scotland, while in the East of Ireland the superficial deposit had been subjected to a considerable sifting action, which had changed its character. The general opinion at the present day is, that this boulder clay is not aqueous drift, but consists of the *débris* of rocks ground down on dry land. Not far from Galway he had observed a sandy clay full of boulders, so compacted together as to form a sort of conglomerate, in parts almost stratified, which had been probably formed by the pushing action of the ice slipping from the land to the sea.

The Secretary read a paper by W. Harte, Esq., C. E., "On a New Echinoderm from the Yellow Sandstone of Donegal" (p. 67). The paper was illustrated by a careful drawing of the specimen on an enlarged scale, for which the Society were indebted to the kindness of Mr. Baily, who, on being called on by the President, observed, that in his opinion the fossil belonged to the genus *Archæocidaris*, but was certainly a new species. He was led to this conclusion from the fact that the whole family of the Cidaridæ presented an appearance like that shown on the specimen—viz., that the plates exhibited one large tubercle. In the more recent specimens all the plates were tubercled, while in this Palæozoic fossil the tubercles only appeared on a few of them. He would only observe, in conclusion, that the Society owed a great deal to Mr. Harte, by whose care and diligence this fossil had been discovered and laid before them, like many others which they had received from the same locality within the last few years.

Mr. Emerson Reynolds then read a short communication upon "Thalliferous Pyrites, from Ballydehob, county of Cork." He said that he had examined several Irish ores for this element since he had laid his last notice on this subject before them in 1863, but that the present specimen was the only one in which he had succeeded in discovering thallium, and here only in small quantity.

The President remarked that, as Mr. Reynolds had kindly brought apparatus for exhibiting some experiments with spectral analysis, it would be better to adjourn the

meeting at once, so as to afford the Fellows and visitors an opportunity of leaving their seats to see the experiments.

The meeting was accordingly adjourned, and the gentlemen present spent some time in examining the apparatus, &c., and seeing the spectra afforded by some of the rarer metals.

MAY 11, 1864.

ROBERT CALLWELL, Esq., in the Chair.

The minutes of the last meeting were read and confirmed, donations announced, and thanks voted.

The ballot was then opened for the election of Fellows and Associates, and at the conclusion of the voting it was announced that the following had been elected Fellows:—A. Gahan, Esq., C. E., Omagh, County Surveyor of Tyrone; H. Russell, Esq., Simmons'-court; R. Glasscott Symes, Esq., Geological Survey, Ireland; and Sandford Palmer, Esq., Roscrea. R. H. Ellis, Esq., was elected an Associate.

Mr. George B. Bradshaw, of 20, Hardwick-street, and Mr. C. R. C. Tichbourne, of the Apothecaries' Hall, were nominated as candidates for election at the next meeting.

Dr. Macalister read a paper on a specimen of *Ulodendron* from the Hurlet coal-field, near Paisley, Renfrewshire (p. 16).

The Rev. Dr. Haughton said that Mr. Macalister showed him the specimen in question shortly after he had decided on bringing it before the Society, and he told him that he was certain that it was the *Ulodendron* of Lindley and Hutton; but that with respect to the large circular radiating scars on the plant, he did not think anybody knew what they were. Whether they were fructifying cones, which had been crushed down by chance, at right angles, on the stem, so as to produce a circular impression, or some unknown and undescribed form of vegetation, it was impossible to decide. They appeared at irregular intervals on the stem. The only markings on the stem itself by which the plant could be distinguished from the *Lepidodendra* were a characteristic and decided difference. The markings were not lozenge-shaped, but rounded off at the top, and thus presented an appearance which at once distinguished them from the ordinary *Lepidodendra*. He had no doubt, from the appearance of the scars, that they were those of the upper part of the stem, near the fructifying portion of the plant. One of the points to be discovered was, why they should bear such an excessive proportion to the diameter, for they were sometimes one-third of the whole diameter of the plant. They were under obligations to Mr. Macalister for bringing the fossil before them.

Mr. Baily.—With regard to the fossil plant noticed by Dr. Macalister, it was not an unusual occurrence for plants of this character to present a different arrangement of markings where the bark was removed from those on the external surface. This peculiarity, being well known to fossil botanists, is accurately represented in the figure of this species given by Brongniart in his "Vegetaux Fossiles," plate 19, vol. ii., where it is placed under the genus *Lepidodendron*. Dr. Hooker, also, in the "Memoirs of the Geological Survey of Great Britain," vol. ii., part 2, expressly alludes to this fact as constituting one of the difficulties attendant upon the correct specific determination of fossil plants. That eminent botanist, in his observations upon the genus *Ulodendron*, in the same memoir, states that its internal structure corresponds very nearly with *Lepidodendron*, although externally it differs from any known recent or fossil plant. He stated that he considered such specimens as that brought before the meeting by Dr. Macalister to be very useful in serving to check the tendency to the multiplication of species to which all palæontologists are liable.

The Rev. Maxwell Close read a paper "On the General Glaciation of the Rocks in the Vicinity of Dublin" (p. 3)

The Rev. Dr. Haughton said, this was not the first time that the Rev. Mr. Close had brought the subject of his paper before the Society. He was peculiarly known as an explorer in that interesting and important branch of geology; and he had added considerably to their obligations to him by his contribution to their proceedings of that evening. The care, labour, and observation required to work out the highly interesting

paper, of which he had given them an abstract, would be appreciated by every person who had to work out a similar problem in such a large district. Mr. Close had made out his case satisfactorily with regard to the principal points which it was important to establish. All the details which he had sketched with so much minuteness of description, showing the general direction of the currents of water, ice, or glacier—for what it was, he admitted, he considered to be an open question—and the markings on the rock from the westward, which afterwards branched off in north-eastern and south-eastern directions respectively from the Leinster hills, were of great and permanent value; and he hoped they would be allowed to publish a map containing the result of the observations which he had made. With regard to the cause of those markings on the rock, he was sure that an observer like Mr. Close would excuse his differing from him in some respects, for he thought that it was a matter not so easily established. There could be no doubt whatever that the facts Mr. Close had brought before them could be fully and satisfactorily explained by the hypothesis of solid ice, and perhaps it was the correct explanation of the phenomena. One point in the paper had struck him as confirming observations of his own, and also observations which had been laid before the Society by their Vice-President, Mr. Kelly—namely, the detailed and accurate statements which it contained as to the height at which these remarkable traces were to be found. He was not before aware that these groovings and marks in the rock could be fixed in altitude so precisely as Mr. Close had done. His own observation of the mountains about Dublin, together with those of Mr. Kelly, had led him to the conclusion that 1200 feet was the fixed level at which large masses of gravel, decidedly drift, were deposited on the sides of the hills. They might find occasional pieces of rock, as Mr. Mallet mentioned in a paper before the Society many years ago, at high elevations; and the same appeared to be true from Mr. Trimmer's observations of the mountains of Wales. He (Dr. Haughton) had great reluctance in theorizing as to these markings or groovings. They were very well described by the term "glaciations," used by Mr. Close. The commonly received theory was, that they had been produced by ice. The argument that floating ice, though it might groove a rock up-hill, never would do so down-hill, seemed to be conclusive as against the application exclusively of the theory of floating ice to the explanation of these phenomena. Many years ago Mr. Mallet brought forward a theory which he thought was capable of explaining many of those groovings, viz., that the body of the land rose, covered with mud, from the sea level, and that the mud slipped on the surface of the land in a direction determined by the *contour* of the surrounding valleys and mountains which were submerged. It was well known to engineers that mud or gravel would, for obvious reasons, stand under water at a much higher slope than either would remain at in air. Therefore, the moment the land rose above the water level, the large mass of gravel and mud lying upon it took a smaller slope than it had before, and slipped downwards. Therefore he thought the question an open one, as to whether these groovings had been caused by ice, or by slipping mud. Mr. Close would excuse him for saying that he thought there was something very hard to conceive in such an extensive and universal mass of ice as he described covering the country. He was one of those who believed that the great majority of the climates that had preceded our present climates were much hotter than it. Individually he was strongly inclined to the theory of mud glaciers, as propounded by Mr. Mallet, *versus* the theory of universal ice; in fact, he did not believe in the "universal ice" theory of Murchison, Agassiz, and the others who had followed the originator of it.

Mr. Kelly said, he was hardly prepared to say much on the subject of these scratchings or groovings. His attention was directed at one time to the gravel which lies on the northern face of the Dublin mountains; and having traced as accurately as he could the different heights at which the gravel was found, he discovered some interesting things. One of these was, that there were places at which there was no gravel at all at a height of 300 or 400 feet, while in other places there was a great quantity of gravel at a height of 1200 or 1300 feet. As for the scratches in question, he did not know what to make of them. The rocks about Dunshaughlin were black shale, very soft, and covered with drift; the country was a fine grazing one, and he did not see any scrapings there.

Mr. Close.—It is the surface of the country that is moulded in ridges running from N.W. to S. E.

Mr. Kelly said he could not bring himself to believe that ice would climb up a hill. He thought some of the little scratches might have been done by ice, but he did not think the Scalp ever was. He thought it and the Glen of the Downs had been caused by some power far greater than ice.

A Fellow asked did Mr. Close suppose that the glacier rose over the Three Rock Mountain.

The Rev. Mr. Close said, he believed it must have gone through the passes of Ballybrack and Glencullen, but not higher. It had certainly climbed up Shankill. A glacier 2000 feet thick could readily have accomplished what was required, as was proved by the appearances on Scotch and American mountains.

The Rev. Dr. Haughton exhibited and explained two fine fossil specimens of *Pterygotus*. He had obtained from the Museum of Trinity College that which was now the second best specimen of this fossil in the world. It had been the best, and had occupied a place in the British Museum until it was supplanted by a superior one.

The Society then adjourned.

JUNE 8, 1864.

The Rev. S. HAUGHTON, M. D., in the Chair.

The minutes of the last meeting were read, compared, and signed, donations announced, and thanks voted.

The ballot for election of Fellows was declared open.

Mr. R. S. Reeves, one of the Honorary Secretaries, read Mr. Harte's paper "On the Physical Features of the county of Donegal" (p. 21).

At the conclusion of the paper, which was received with marked approbation, the Chairman said that he regretted very much Mr. Harte's absence; for he was sure the gentlemen present would have derived additional benefit from the paper had the author read it himself, his professional duties giving him the advantage, on account of his intimate and accurate knowledge of the county of Donegal, on the geology of which no gentleman in the Society was more competent to offer an opinion; that his own knowledge of Donegal was only general, and he did not remember to have ever seen the submerged bog; but, nevertheless, he did not entertain the least doubt as to the accuracy of Mr. Harte's observations. He understood that Mr. Harte had delayed sending that paper, in order that he might have the opportunity of testing the accuracy of his sections, by taking the levels with the spirit level. He could not refrain from remarking that the county of Donegal is scored with valleys from N. E. to S W., and even the granite is split by a great valley; and these valleys do not correspond with the valleys of denudation in other parts of Ireland. Some of these valleys terminate abruptly on reaching the sea, where they end in gently sloping masses of gravel and sand. Connected with this he had made some very curious and interesting observations, which at first sight appeared to throw light on the glaciation or scoring of rocks. Presuming that there were but two theories of glaciation received nowadays by geologists, it was still very curious that this phenomenon of the abrupt termination of valleys could be explained on either hypothesis; for, if the scoring be due to the action of ice, the ice would float as soon as the glacier reached the sea, so that the land would be relieved of the great pressure, and the erosive force of the ice destroyed. If, on the other hand, the scoring be due to the motion of mudbanks slipping off the land as it rose out of the sea, it is evident that, as soon as the elevating action ceased, the scoring would cease too, at a height close to that of the present sea level. Thus we see that the results would be the same, although the action would be somewhat different.

The Rev. Mr. Close said, the phenomenon of the rock-scoring or glaciation in the neighbourhood of Dublin was somewhat different from that observed by Mr. Harte. He considered the glaciation described by Mr. Harte was posterior to and more local than that observed and described by Mr. Bryce in the Proceedings of the Society, and subse-

quently observed by himself; but he had seen examples of the former in the lowlands near Dublin.

Mr. Rowan made a few observations on the subject of the paper; and, the ballot being closed, the following gentlemen were declared unanimously elected as Fellows of the Society:—G. B. Bradshaw, Esq., 20, Hardwick-street; C. R. C. Tichbourne, Esq., Apothecaries' Hall; C. W. Bateman, Esq., 71, Rathmines-road.

The Chairman, in adjourning the meeting, said that he hoped that the dignity which had been conferred upon the Society during the past year would not be any impediment to its advancement and popularity, but that, on the contrary, it might stimulate them to renewed exertions. He hoped they would not be led away from the study of really useful geology to that of mere fantastic theories, which save a great deal of trouble sometimes, but which really advance the science very little, if they do not actually retard it.

The meeting then adjourned till the second Wednesday in November.

NOVEMBER 9, 1864.

ROBERT CALLWELL, Esq., in the Chair.

The minutes of the last meeting were read, compared, and signed. The donations were announced, and thanks voted.

Mr. Scott said, the first business was to submit a Report from the Council, relating to the changes in the by-laws which had been rendered necessary by the recent changes in the constitution of the Society. When it was announced in April last that the Society had been constituted "The Royal Geological Society of Ireland," a reference to the Council became necessary, in order to see whether any changes should be made in the by-laws. A sub-committee was appointed, which presented to the last meeting of the Council a Report, which was to the following effect:—

"That the Society be recommended in future,

"1. To change the 10*l.* life composition into ten guineas.

"2. To change the 5*l* life composition into five guineas.

"3. To change the 1*l.* and 10*s.* subscriptions into guinea and half guinea subscriptions, and the 1*l.* admission into one guinea.

"4. That the election of Fellows shall take place at the February meeting, with power to the Council to order a supplementary election at the June meeting.

"5. That not more than ten Fellows be elected at the February meeting, nor more than five at the supplementary election in June."

The above recommendations, if carried out, would not in any way affect the existing Fellows. Any person who had entered the Society upon the understanding that he was to pay 1*l.* a year would continue to enjoy that privilege. But any gentleman who should be admitted after the passing of the resolutions now about to be proposed would have to pay one guinea entrance fee, and one guinea subscription. The election to the Fellowship would take place only twice in each year; but undergraduates would be admitted as before, and no change would take place in the rate of their subscriptions. He therefore moved that the above recommendations be adopted.

Mr. Doyle seconded the motion, which passed unanimously.

The following gentlemen were admitted associate members:—Mr. J. P. Wall, 16, Trinity College; Mr. J. E. Gore, Merrion-square; Mr. Frederick A. Butler, Rathmines.

Mr. Scott stated that the "Journal" of the Society for last session was ready, and would immediately be distributed to all members whose subscriptions were paid up for 1864. It finished the series of ten volumes of the "Journal" of the Society under its former name; and the publication would be continued, with a slightly varied title.

The Secretary read Mr. Foot's paper "On a recent Erratic Block" (p. 32).

Mr. Close observed that instances of recent glacial action similar to the above had been described by the late Hugh Miller as being of not unfrequent occurrence in the northern part of Scotland, and that it was interesting to see that similar facts had been observed in our own country.

The Chairman said, that he regretted to have to announce that the author of the next paper (Professor Haughton) had been unavoidably compelled to leave town; however, Mr. John Kelly had furnished them with a paper, containing his views on "The Doctrine of Characteristic Fossils" (p. 34), which was read by Mr. Scott.

Mr. Baily said that he did not think it right that such sweeping assertions as were made in the paper against geologists and palæontologists should remain unanswered, as he considered the conclusions with respect to the fossils arrived at by the author of the paper had been derived from insufficient and erroneous data, and therefore did not give anything like a fair result for such comparisons and deductions as he had made with regard to what he considered to be the true nomenclature and position of certain rocks which had been referred to the Carboniferous, Devonian, and Old Red Sandstone formations. With respect to Mr. Kelly's statement as to a falling off in the estimation in which certain fossils called characteristic had been held as a means of identifying the true position of strata, Mr. Baily maintained that no such decrease in their value in that respect had occurred, particular species and groups of species being still characteristic of certain formations and their minor divisions. The advance made in our knowledge of these extinct forms and their true relations shows that, as in all other departments of nature, there are no hard lines, but a blending off or gradual passage of one form into another, so has it been in former periods of the world's history; and although some of the connecting links have yet to be discovered, there are evidences of the series of rocks having passed gradually one into the other, with a corresponding graduation and blending of the life of the period, and that such was, in all probability, the case between the Carboniferous and Old Red Sandstone, some of the rocks in dispute, which had been termed Devonian, being merely transition or passage beds between the two formations.

DECEMBER 14, 1864.

THE PRESIDENT in the Chair.

The minutes of the last meeting were read, compared, and signed, donations announced, and thanks voted.

Mr. Goodwin White, of 48, Harrington-street, was admitted an Associate.

The Rev. Dr. Haughton read his paper "On the Geology of some of the Western Islands of Scotland" (p. 28).

Mr. Baily said that, as Professor Haughton had been kind enough to allude to him, he would make a remark on the fossils. He drew the fossils of these islands originally for Professor Forbes, and he also drew them for the Duke of Argyll, and the drawings are published in the "Geological Journal." The value of these fossils was greater than perhaps one might suppose, because the Western Islands presented certain evidences of the existence of Oxford clay, and the same clay occurred no nearer, in England, than on the coast of Yorkshire. This showed the value of characteristic fossils. One little fossil in the slab before them enabled him to distinguish it as being Oxford clay. It was the only fossil found in that clay, or it was at least the fossil which was most abundant in it. He thought the contribution a most valuable one to their knowledge of the Western Isles. They had previously had no evidence of the existence of Oxford clay there except the fossils mentioned by Professor Forbes, which were fresh-water fossils.

The Chairman observed that a high value belonged to the Azoic portion of the paper, and especially the discovery of the rock which connected the old world with the new. In reference to the curious little arm of the sea (Loch Scavaig) which Professor Haughton had described, a friend of his, General Sabine, the President of the Royal Society, observed a very singular physical phenomenon on entering that loch at night. There was an aurora borealis, and he distinctly saw the auroral streams issuing from the Syenitic rock—an appearance which he was enabled to confirm by changing his place. If this should be established as a fact, it would throw a flood of light on a very obscure question.

The Rev. Dr. Haughton said, he had omitted to state that the geology of the islands in question derived an additional interest from the observations of General Sabine, to

which the Chairman had just alluded, as to the magnetic properties of the rocks. The Labradorite and Augite rock of Skye contained a large quantity of magnetic iron of a high specific gravity, and which, as he had mentioned, resembled the syenite of Donegal. Colonel Sir Harry Jones, who, as head of the Royal Engineers, had been engaged in investigations for the purpose of comparing the measured arc of the meridian in England with arcs measured in France, Prussia, Russia, and Italy, told him that, on approaching Aberdeen, a deviation of the plumb line occurred, which he was quite unable to explain. He showed him a specimen similar to the rock now on the table, which contained a large quantity of magnetic iron, and stated that he believed it extended in a broad band through the North of Scotland. It had a specific gravity which was very high, and capable of influencing both the magnet and the pendulum. There were no questions of greater interest in connexion with the theory of the earth than those which were opened up and explored by such investigations conducted for the purpose of measuring the arcs of the meridian. Professors Maskelyne, Hutton, and Playfair had been completely baffled in their investigations in connexion with the mountain Schiehallien. He believed the cause of that to be that they had omitted to take into account rocks of exceptional density, and had in consequence estimated the density of the mountain too low, and accordingly derived too low a density for the earth. There was reason to think that rocks of the character just alluded to ran through Schiehallien. Corrections by modern physicists of their observations went to show that, if they had known what the real weight of Schiehallien was, they would have got at the real specific gravity of the earth. From observations which he himself made at Loch Scavaig with a pocket compass and also with the compass of the yacht, he was perfectly satisfied that the mountain was what an ancient mariner would have called a loadstone, which was due to the large quantity of magnetic or titanic iron in it.

The Chairman observed that General Sabine, Professor Phillips, and himself, while engaged in the magnetic survey of the kingdom, made observations and calculations which, when collated, went to show that the magnetic disturbance in England—in which country sedimentary rocks are the most prevalent—was least; that that in Ireland was next; and that in Scotland was the highest of all.

Mr. Ormsby said.—I had the pleasure of taking a yachting excursion to the Western Islands of Scotland in the summer of 1863, and visited many of the places just mentioned by Professor Haughton. In his paper, Dr. Haughton told us that it has been remarked that many of the islands are formed of Secondary or Tertiary rocks, covered with a layer of trap or basalt, as is the case in the county of Antrim. This is to be seen in a very remarkable manner in Eigg, a small island lying between Mull and Skye. The base of the island is formed of soft clay and amygdaloidal trap; these cover a layer of Oolitic shales, containing the rare fossil, *Pinites Eggiensis*, and the whole is covered with a towering mass of porphyry, rising to a height of 1300 feet above the sea. This confirms to some degree Professor Forbes' theory, that the igneous rocks of the Scotch islands have been poured out at widely different times, from the older to the more recent periods. The amygdaloidal base of the island is penetrated by some curious dykes of "pitchstone," one of which is very peculiar. It consists of two distinct veins, one black, and the other whitish; and when these meet, the rock assumes a green colour, and looks like a mass of common bottle slag. This trap is very soft; and consequently all along the sea-beech is hollowed out by the waves into huge dark narrow-mouthed caverns. A very interesting story is connected with one of these caves. In the reign of Mary Queen of Scots, the M'Leods of Skye and the Eigg men were at war with each other, and the Skye men came to attack Eigg. The unfortunate inhabitants fled for refuge to one of these caves, and being discovered by leaving some footprints on the snow, were all smothered together by their enemies. Sir Walter Scott tells the story in his poem, "The Lord of the Isles." To the west of this district we find more aqueous rocks. A broad band of Sandstone, apparently Triassic, rises up, overtopped in some places by Liassic Shales. Along the shore the Sandstone is most disintegrated, and forms a clear white sand. This is called by the inhabitants the "singing sands," from the fact that when they are struck by the foot they emit very singular, almost musical, notes. The noise seems sometimes to be like the sound of an Æolian harp, but reminded us more of the squeaking of a flock of young turkeys. There are but two other known places in the

world where similar singing sands are to be met with—one is in Arabia Petræa, and the other on the borders of Thibet and Tartary. Further west lie Liassic rocks. In some boulders lying over them Hugh Miller found, some years ago, a number of Saurians' teeth, but lately entire specimens have been obtained from the shale, some of which are to be seen in the Museum of the Glasgow University.

The meeting then adjourned.

JANUARY 11, 1865.

The PRESIDENT in the Chair.

The minutes of last meeting were read, compared, and signed. Donations were announced, and thanks voted.

Mr. Robert H. Ellis was elected an Associate of the Society.

Mr. Scott, as Hon .Secretary, read a paper by Dr. Lauder Lindsay, "On the Geology of the New Zealand Gold-fields" (p. 49), and the following extract from the report of Dr. Hector to the Royal Commissioners of the New Zealand Exhibition:—"The mineral wealth of some parts of the province of Auckland is well ascertained. The copper mines at Kawan and Barrier Island were at one time worked to some extent, and, though now abandoned, they could be easily represented in the Exhibition by suitable specimens and plans of the workings. Through the attention of the Government, I was enabled to pay a visit to Coromandel, and to examine the auriferous district there. Although belonging to a very different class of diggings, as regards extent, from those we are accustomed to in Otago, they have yet proved highly remunerative to some of the parties who have worked them steadily, and especially where they have avoided launching into the reckless prospecting schemes which appear to have been too frequently adopted, and which I have no doubt, by the want of success, have caused the real value of the auriferous lands to be much underrated. Gold was first discovered in the year 1852, but it was not till ten years afterwards that it was worked in earnest. The formation does not resemble anything in the south of New Zealand, but is analogous to the Grass Valley district, in California, and Woods Point, in Australia. The superficial drifts are here almost wholly wanting, and in a very short time the small quantity of alluvial gold that was to be found in the bed of the stream was washed out. It is a most delightful district, bordering on a land-locked harbour, where, owing to the facilities for procuring food, if gold were plentiful, a digger's life would be luxurious. During the first rush of population to this place several townships were laid out, and the land was readily bought. Now, however, the white population is only 300 persons, of whom eighty-one held miners' rights during the past half year. The native adult population numbers 340. Excluding the yield from the alluvial diggings, the quantity of gold which has been extracted from the reefs during the last two years amounts to 8422 oz.; but of this 7800 oz. have been obtained by two companies alone. One of these, known as No. 5, has now divided among the shareholders the sum of £11,050 sterling, without having ever made any call; the expense of working and management, amounting to £3000, has been invariably paid by the yield. The same auriferous rocks that occur in the neighbourhood of Coromandel extend for an unknown distance in a southerly direction, but the present native disturbances have hitherto prevented the examination of the country."—*From the Lyttelton Times, Oct. 13th*, 1864.

The Chair was here vacated by the Rev. Dr. Lloyd, who was obliged to leave, and was taken by the Rev. Dr. Haughton.

Mr. Gilbert Sanders said, he thought it not out of place on that occasion to offer a few words in reference to the gold valleys of the county of Wicklow. They had much more interest in them than in those of New Zealand, although he was sorry to say that the former fields were as yet not quite so productive as those which had just been described. He had not prepared a formal paper, but would simply describe the proceedings of the Carysfort Mining Company, who had at present the working of the Wicklow Gold-fields. The geology and the mineralogy of that entire district, and more especially of the gold valleys, had been so fully described by many geologists, that it was unnecessary

to speak of them; but the fact was, that he might adopt the geological descriptions contained in the papers just read as applicable to the Gold-fields of the county of Wicklow. The parallel between the two districts was so complete, that he could almost fancy that the gentleman who described the New Zealand districts had never stirred beyond the valley of Croghankinsella. It was a singular thing, that at the antipodes of the world there should exist two Gold-fields agreeing so closely in their geological relations. The object of the Mining Company in their explorations was to discover if there were in existence, at or near the surface of the ground, a vein of quartz or other mineral from which the gold that was now distributed over the surface of the land originally emanated. They had examined the rock wherever it was laid bare by nature, and had inspected numerous veins of quartz; they had blasted portions of rock, and had crushed the quartz. Some of the more promising lodes of quartz had been pierced by shafts of a couple of fathoms deep. As yet, however, no stone containing gold had been found in the Croghankinsella district—that is, nothing which could be properly called a vein of gold-bearing stone. The searches which had been made into the deposits in the valley showed a wide distribution of the particles of gold. Of those particles which could be called nuggets the larger were found at the upper parts of the streams towards their sources; and as they descended the streams, the particles became much more minute. That was not, perhaps, an absolute rule, but was generally the case. From the facts which had been brought to light—from the examinations which he had himself made, and from the reports which he had heard from others, he had no doubt whatever that the original source of the gold was high up towards the sources of these streams. It was reasonable to suppose that the smaller particles should be more easily swept down, while the larger masses would hold their position amongst the rocks during a series of ages. Therefore they should look for the original source of the gold, not in the valleys below, but in the upper part of the Croghankinsella mountain. The papers which had been read described the gold of the districts referred to in them as found for the most part in metamorphic slates, such as the Silurian slates of the county of Wicklow. Amongst such slates in that county they found gold deposited. The Auckland gold was said to be met with in the chinks of rock where the edges of that rock protruded through slate. They found in Wicklow no quartz bearing gold; but they did find there gold carrying portions of quartz with it. It was to be supposed that that gold came from a quartz vein. He had seen many specimens of gold containing quartz, but he had never found there any masses of quartz with gold imbedded in them, such as were found in other parts of the world. They had examined a great many of the quartz reefs, of which there were an immense number running through the slate across the valley, and in no instance yet had they discovered gold in those reefs. Yet it was impossible to imagine that the gold could be anywhere except in those quartz reefs. At the time the Government worked the district, their engineers were of the same opinion, and examined a great many of those reefs. They ran an adit of 120 fathoms, which he had been in, and which cut through not less than from 50 to 60 quartz veins, some of them of from a foot to two feet in breadth, but not one of these had yielded the smallest particle of gold that he was aware of. The question was, how was the presence of gold in the Croghankinsella valley to be accounted for. Dr. Lindsay stated that at the Auckland Gold-fields they had spent £2000 in collecting £1100 worth of gold. The Mining Company had spent something more in proportion in collecting gold in the county of Wicklow; notwithstanding that, they believed that the indications afforded there fully warranted the directors in pursuing their investigations. Hitherto the gold found in Wicklow had been found in the streams, or taken from the washings of gravel, or "dirt" as the miners called it. The company had "costeened" the surface of the mountain to a considerable extent, but up to the present they had not succeeded in discovering the lode from which the gold originally proceeded. In working at the lower portions of the rivers they had sunk shafts under the soil to the rock below, and had from thence collected gravel, from which gold had been washed out. Lately a discovery had been made on their property of a very large "gossan" lode. This was a lode which he believed must have at one time contained gold, but the gold had been washed out, or otherwise eliminated during a long course of ages, leaving nothing behind except an ochreous matter. The paper, treating of the Auckland fields, stated that magnetic iron was also found there. It was a re-

markable fact that iron sand of a similar description, and perfectly magnetic, also existed in the county of Wicklow. Mr. Sanders showed some of this sand, which had been taken from the washings there. It was stated in "The Field" of the 7th of the present month, that no gold had been found in Ireland, and that the gold used in the manufacture of the antique Irish ornaments, which were preserved in museums, was brought here by foreign merchants, who took in return for it the inhabitants of the country, who were sold to them as slaves by the lords of the soil. In reply to, and in contradiction of this statement, he had only to exhibit the result of a smelting which he had himself made. This, he stated, had been obtained from Carysfort materials. It will be remembered that a mass of gold was shown by Mr. Sanders at the last meeting of the Carysfort Mining Company. The mass now exhibited was the additional result obtained from operations which Mr. Sanders then stated that he had not had time to finish. It was valued at about 120*l*. Mr. Sanders, in conclusion, mentioned that tin, lead, and copper were also found in the Wicklow valleys.

Mr. Scott exhibited a nugget and a model, the former of which had been taken from the Wicklow district in the year 1796, shortly before the breaking out of the rebellion. The "model" is a gilt leaden image of what was the largest nugget of rolled gold ever found in Europe. It weighed 22 ounces, and had also been found in Wicklow. Several other models of the same nugget are preserved in different museums. The smaller nugget, which is a genuine sample of the Wicklow gold, now belongs to the mineralogical collection of the Royal Dublin Society. It consists of a mass of gold through which a vein of quartz runs, and was found by Mr. Scott to weigh 1500 grains.

The Chairman said, he regretted that Dr. Lloyd had been obliged to leave, as it was his intention to have stated some views entertained by his father respecting the Wicklow gold mines. (*See* First Annual Address to the G. S. D., p. 16.) Dr. Lindsay, of Perthshire, whose paper on the New Zealand Gold-fields the meeting had heard, had desired that his paper should be brought before the Irish Geological Society, because he considered that the Gold-fields of New Zealand bore a more striking resemblance to those of the county of Wicklow than any others that he was acquainted with.

Mr. J. Knight Boswell said, that the failure of the Government effort to find gold in the county of Wicklow, in 1796, was no reason why the present mining operations which were conducted there for that purpose should not be persevered in. It was many years since he first visited those mines, and purchased gold from the people there. He had in his possession a beautiful specimen of that gold—a piece of quartz, with gold all round it, which was evidently the effect of water. He then formed the opinion that the gold came from the quartz reefs of the district, and that whoever should discover those quartz-bearing reefs would make a princely fortune; and he had not changed that opinion since. He believed that at a very remote period, when the surface of the soil there was utterly destitute of vegetation, masses of gold were carried from the upper parts of the mountain downwards by the action of water. In the course of subsequent ages a deposit of vegetable matter or peat had accumulated to the depth of from fifteen to twenty feet, so as to hide the site of the original quartz reefs. He would mention a circumstance which he heard from a family named Byrne, who were farmers at Croghankinsella, some thirty years ago. They said that in the upper part of one of the rivers they found a mass of metal, about a pound and a half in weight, which they supposed to be copper. It remained for several years in their possession, and was used by them as a weight; but at length it was disposed of to a travelling tinker, who carried it to Dublin, where he sold it for a large price to a jeweller in Capel-street. That was what led to the Government investigations there in 1796; and it was stated on the authority of Government, that at that time, during a space of two months, 10,000*l*. worth of gold was purchased from the people of the district by jewellers in Dublin.

Mr. Baily said that at a former meeting of the Society he made a communication on the subject of the New Zealand Gold-fields, embracing a sketch of the geology of the district derived from various sources. He had examined some fossils taken from Eocene beds near Otago. The rocks along the eastern coast there were Tertiary, and from one of them had been taken fossils resembling those of London clay. One of the authorities from whom he had made his communication spoke of the Gold-fields of that district as in general resembling those of Australia. Mr. Vincent Pike, in his report, said he

believed the prosperity of Otago, as a gold-producing country, was likely to be permanent and progressive. At the last London Exhibition Canadian gold was exhibited by Sir William Logan; but it had been obtained at so great an expense, that the mines from which it was derived were not workable. In general, gold was everywhere diffused through rocks of a similar character.

Mr. Scott said that it was stated by Mr. Weaver that the amount of gold raised in Wicklow during the period of the Government operations in 1796 was about 9000*l*. worth.

The Chairman (Dr. Haughton) said, this was a most interesting subject, and that Society was the proper place for the discussion of it. The first point that occurred to him was the extraordinary manner in which the gold occurred in the localities referred to. The large "model" which had been just inspected by those present represented a very celebrated Wicklow nugget which, some people said, had been presented to George the Fourth. Without prejudging that question, there was no doubt that it was a very remarkable specimen, and the Museums of Trinity College and the Royal Dublin Society, and the British Museum—in fact, all the museums had copies of it. The peculiarity of it was, that the gold appeared to consist of masses conglomerated or lumped together. The other which had been exhibited was real; and was of the same character as the mock one, being also a specimen of rolled gold. With respect to gold of that description, the problem was, to determine how it came to assume that form, it being known that gold was most difficult to be affected by fire. These nuggets would appear to have either been fused by heat, or to have been welded together mechanically. The next question which arose—namely, as to where they came from—was of still greater interest. He was perfectly well acquainted with the chemical composition of every part of the Croghankinsella mountain, which was most remarkable. No other granite mountain had such an extraordinary diversity of composition as it possessed. On its slopes were the gold-bearing streams which had made Wicklow famous, and the sands of which contained magnetic iron and other minerals, the connexion of which with gold was at present very obscure and ill-understood. Why those streams should carry down masses of gold was, in the present state of science, incomprehensible. How the gold came to be originally in the higher parts of the mountain, and also how it was blended together in masses, as was evident in the nuggets produced, were problems yet unsolved. He agreed with Mr. Sanders, and the other gentlemen who were associated with him, that those questions were of the greatest importance, and should be solved. The quartz reefs containing the gold must be found. He was not an antiquarian, but he thought it was a mistake to suppose that the gold which the ancient Irish used in the manufacture of their ornaments came from abroad. He believed that every particle of it came from Wicklow, and that the trade which some antiquarians alleged to have existed in gold between Ireland and Spain, and other countries, was a delusion. There was no satisfactory evidence that gold was then found in any other part of Ireland except Wicklow, unless, perhaps, a small quantity in Mayo and some other parts of the West of Ireland; and he believed that the cross of Cong, the torcs, and the other ornaments, were made by Irish workmen, of gold found at Croghankinsella. It was right to say that he believed the farther we went back in time the larger were the nuggets that had been found in these Wicklow districts, so that in all probability those from which Malachy's collar was made were six or seven times larger than any now to be met with; and until we reached the quartz gold-producing reef, he did not believe that we should get any more large nuggets. It appeared to be a law that, in old times, through causes unknown, the quartz reefs were altered, and large masses, like the model, were produced, amalgamated by forces that we now do not understand. That the first diggers carried off the largest nuggets appeared to be true of the searchers in all gold countries; but he believed a very rich harvest was open to those who should explore the gold fields of Wicklow.

Mr. Sanders, in reply, expressed his confident belief that there was nothing in the facts as now known with respect to the Wicklow district to discourage the Carysfort Company from continuing their operations. He believed that the gold-bearing vein did exist somewhere at Croghankinsella. A theory had been broached by some that the gold of Ireland had been transported here from other countries by icebergs at a remote period. He did not believe in that theory. The largest Wicklow nugget that ever

came under his observation was one of 320 grains. The fact was remarkable, that all over the world deposits of gold, when found, were associated with quartz rocks.

The Chairman, on closing the discussion and adjourning the meeting, said that the next would be the first annual meeting of the Fellows of the Society under its new constitution. Any persons whom on that occasion it was intended to propose as Fellows should be proposed within the next fortnight, or else they could not be presented for election for twelve months.

The Society then adjourned.

Anniversary Meeting, February 8, 1865.

The Rev. S. Haughton, Vice-President, in the Chair.

The minutes of last meeting were read, compared, and signed. Donations were announced, and thanks voted. The ballot for Officers and Council for the ensuing year, and also that for election to the Fellowship of the Society, was declared open.

The Chairman begged to make an explanation in reference to the election of Fellows. A list of twelve gentlemen, who were candidates for Fellowship of the Society was now submitted. He was very sorry, however, that on that occasion only ten of them could be elected. All appeared to be eminently worthy of the distinction; but the rules of the Society rendered it impossible at that meeting to vote for more than ten names.

Mr. Callwell and Dr. Carte were then appointed scrutineers of the ballot for the Officers and Council.

Messrs. Cotton and Bennett were appointed scrutineers of the ballot for new Fellows.

The annual report was then read by Mr. R. H. Scott, one of the Honorary Secretaries (p. 69).

The Chairman congratulated the Society upon its present position, and upon the report which had been read. The older members of the Society could recollect when it was but a struggling one. It could boast of thirty-four or thirty-five years of existence, but not of prosperity; but, as was the case with all societies and individuals who were worth anything, its struggles had only tended to develope its qualities. Many years ago its meetings used to be held in the Custom House. The famine came in the years 1846 and 1847, and they were turned out of the Custom House. Then they were afforded comfortable accommodation within the walls of Trinity College. He believed that many gentlemen who were connected with the Society were dissatisfied with that move; but every one was now agreed that it was a great step in advance, and a great benefit to the Society. It had been the means of founding in that University a magnificent geological museum, which he did not think would have existed but for the influence of that Society; and also of exciting in the University a spirit of geological research of which they could not foresee the end. They were now the Royal Geological Society of Ireland, and it had been felt to be most important to place the constitution of the Society as respected its Presidents on a final and satisfactory basis. It had been constantly found difficult to find Presidents year after year, and at length the most desirable course appeared to be to secure a permanent President. When this idea was mooted, it became manifest that the most eligible person for that office was the Earl of Enniskillen. He had many claims upon public notice as to which they had nothing to say; but as a geologist, they had no hesitation in saying that he was the proper person to represent that Society. He possessed the most valuable private museum that any gentleman either in Ireland or England possessed, containing a collection that would be a credit to any museum, public or private; and it was well known that, from the time when he was Lord Cole, and even from his boyhood, his geological tastes were known, not only in Ireland, but throughout the world. He was, therefore, the proper person to be the President of a Society which aimed at representing, not merely Dublin, but the whole of Ireland. He had in the kindest manner consented by letter to become their President as soon as he became aware of the proposed alteration in their rules. It would not be possible for him to attend every meeting of the Society, but he would attend as often as

possible, and he would represent the interests of the Society in influential quarters. According to the new plan, it was intended that the Society should be worked by its Vice-Presidents, while their President should hold his place perpetually, and this he believed to be the true view of their position. He was glad to find that the sanction of the Society was accorded to this plan. With reference to the papers which had been read before the Society during the past year, it would perhaps be invidious to call attention too particularly to any; yet he could not help observing, that the paper which had been submitted by Mr. Close was unquestionably entitled to be eulogized as the paper of the year. The patient industry which it evinced, and the principles which had been laid down in it, rendered it just that he should say so; it was perhaps the most important paper laid before any geological society during the past year. The importance of a paper was not to be marked by the magnitude and importance of the society before which it was read. A hard worker in science might discover facts and phenomena which he had only an opportunity of laying before what, he was sorry to say, was considered but an obscure provincial society like this. It was the fact that they were regarded by their brethren in England as a very obscure and very provincial society; but he would be content with such provincialism if they could continue to produce papers such as he had alluded to. The Chairman concluded by a tribute to the memory of the late Assistant Secretary of the Society.

The result of the ballot was then declared, as follows (see List of Officers and Council, p. 76):—

Fellows Elected—John M. Fleming, Esq.; John Gibson, Esq., M. I. C. E.; Robert Armstrong Gray, Esq., C. E., M. R. I. A., County Surveyor of the Northern Division of the County of Dublin; Thomas Maxwell Hutton, Esq.; Arthur Jacob, Esq., B. A., Executive Engineer, Public Works Department, Bombay Presidency: John Leech, Esq., C. E., General Survey and Valuation Department; Alexander M'Donnell, Esq., C. E.; George Porte, Esq., M. R. I. A., and M. N. H. S. D.; J. Middleton Scott, Esq, B. A., C. E., Government Telegraph Department, Bengal; Rev. W. Steele, M. A., Head Master, Portora Royal School.

The Society was then adjourned.

XVII.—NOTES FOR A COMPARISON BETWEEN THE ROCKS OF THE SOUTH-WEST OF IRELAND, AND THOSE OF NORTH DEVON, AND OF RHENISH PRUSSIA (IN THE NEIGHBOURHOOD OF COBLENTZ). By J. BEETE JUKES, M. A., F. R. S.

[Read May 10, 1865.]

INTRODUCTION.—In the autumn of 1861 I was able, on my return from leave of absence abroad, to spend a few days in examining parts of Devon and Cornwall, with the view of comparing the rocks there with those of the south-western corner of Ireland. I was so much struck with what I saw, that I fully intended to return the next year, and carry on the investigation, but have never been able to fulfil that intention. Last year I saw a little of the Rhenish rocks in the neighbourhood of Coblentz, and was similarly struck with them. I hope, if circumstances allow me, and official duty does not prevent, to be able still to pursue the comparison of the rocks of these localities with our own; but in the meantime think that, if I lay before you a brief account of the observations already made, and the conclusions deduced from them, it may possibly induce other geologists, whose time is more at their own command, to become fellow-labourers in the task.

Briefly stated, this task is to institute a detailed and accurate comparison of the rocks and fossils of the county of Cork with those of Devon and Cornwall, and of both of these districts with the rocks and fossils of Nassau, Rhenish Prussia, and Belgium.

For descriptions of the rocks and fossils of the South-west of Ireland I must refer you to the published Maps, Sections, and Explanations of the Geological Survey; but I will give here a brief abstract of those descriptions.*

The South of Ireland.—The Old Red Sandstone of Wexford, Kilkenny, and Waterford is similar to that of Pembroke and Caermarthen in lithological character, thickness, and position. In South Wales it

* In the fifth volume of the first series of our "Journal" is a paper of mine, read March 10th, 1852, entitled "Sketch of the Geology of the County of Waterford," in which is advocated the retention of the term "Devonian" for all the rocks (including the Old Red Sandstone) between the Silurian and Carboniferous; and it is proposed to take the lowest bed of Carboniferous Limestone as the base of the Carboniferous series, and to consider all below that as "Devonian." I believe I was right in identifying the beds below the Carboniferous Limestone of Waterford with those of Devon, of which I had seen something in company with Professor Sedgwick many years ago, though it was not till 1862 that the true relations of these rocks first struck me.

In the seventh volume of our "Journal" will be found a paper by myself and Mr. Salter, read June 13th, 1855, entitled "Notes on the Classification of the Devonian and Carboniferous Rocks of the South of Ireland." If the word "Devonian" were omitted from that paper, there is nothing else in it which I should wish to change.

gets much thicker as it is traced eastwards from Pembrokeshire. In Ireland it thickens towards the west, till in Cork and Kerry it attains a thickness of many thousand feet, and its base is no longer seen.

It is somewhat affected by slaty cleavage even in Waterford; but in Cork and Kerry this becomes so marked, that it often assumes the character of a *clay-slate formation,* the prevailing colours of which are purple and green. Some of these slates are scarcely distinguishable from the Cambrian slates of Wicklow or Caernarvonshire in lithological character. It is, however, absolutely continuous from the city of Waterford to the extreme south-western headlands of Cork and Kerry, so that a man might walk from one end of that tract to the other without ever leaving the Old Red Sandstone, except for about a mile in the valley of the Blackwater, between Lismore and Fermoy, where it dips beneath the Carboniferous Limestone.

The red conglomerates and sandstones of Waterford may thus be seen to be physically continuous with the purple and green clay-slates and sandstones of Cork and Kerry.

The Old Red Sandstone is thrown into numerous large anticlinal and synclinal folds over axes which at first run east and west, but as they are followed westwards curve to the west-south-west. Through the counties of Wexford, Waterford, Kilkenny, Tipperary, and Limerick, and the northern parts of Cork and Kerry, we have the Carboniferous Limestone, with a thickness of one or two thousand feet at least, coming in over this Old Red Sandstone, the two being separated by some beds of black shale, for which the most convenient name is the "Lower Limestone Shale." These black shales are in some places not more than twenty or thirty feet in thickness, in others two hundred or three hundred feet. Beds of flaggy limestone sometimes occur in their upper part, beds of flaggy sandstone sometimes in their lower portion, so as to produce the appearance of a graduation from the Old Red Sandstone into the Carboniferous Limestone. This description of the Lower Limestone Shale will, I believe, apply equally to South Wales and the neighbourhood of Bristol.

The line that can be drawn between the red slates and grits in which there are no marine fossils, and the grey slates and grits above them, in which marine fossils occur, was first pointed out by Mr. Andrew Wyley, who was then on the Geological Survey of Ireland. Plants, and I believe the same species of plants, occur in the rocks both above and below that line. The animal fossils are quite distinct. There is, however, one little element of confusion in the use of the term "Yellow Sandstone." In the South of Ireland we have used this term for the upper part of the Old Red Sandstone, the beds immediately *below* the line. I believe that Sir R. Griffith applied it in the North of Ireland to sandstones interstratified with the beds containing Carboniferous Limestone fossils, which would therefore be *above* the line, and perhaps represent our Coomhola Grits. There is, however, no necessity for correlating the North and South of Ireland at present, or for introducing this embarrassing term—"Yellow Sandstone"—into the discussion at all.

The "Lower Limestone Shale" of Ireland also thickens towards the south-west, and is traversed by slaty cleavage, so that its *shales* become *slates*. Even the Carboniferous Limestone itself in the neighbourhood of Cork and Macroom is often so affected by cleavage as to lose its character of a good marble and building stone, and is only useful for making lime. The Coal-measures of Cork and Kerry are as much a *clay-slate formation* as are those of Devon and Cornwall, though they are not anywhere quarried for roofing slate as they are in the West of England.

Near the city of Cork, and the village of Carrigaline, the Carboniferous Limestone still shows itself in the synclinals of the Old Red Sandstone; but the grey slates and grits which intervene between the two are at least a thousand feet thick near Cork, and two or three thousand near Carrigaline.

Farther south, towards Kinsale, these grey slates and grits are certainly five or six thousand feet thick; and they retain that thickness, and a similar lithological character, over all the country to the westward, to the extreme western headlands of Bantry Bay. Throughout all that region there is no Carboniferous Limestone over them; but I now believe, chiefly upon palæontological evidence, that certain patches of black slates, which occur as the highest beds in certain small areas, are the basal beds of the true Coal-measures.

For the great mass of grey and black slates which thus repose on the Old Red Sandstone of the south-west of Cork, Sir R. Griffith's name of *Carboniferous Slate* is very appropriate; while for the grit beds which occur in it, sometimes as single beds of 2 or 3 feet, sometimes as groups of beds of 20 or 30 feet, or 200 or 300 feet, or, as in the far west, 2000 or 3000 feet, I adopted the name of *Coomhola Grits*, from the name of a place in Bantry Bay.

There is no known instance of any local unconformity, or even of overlap, among the beds now spoken of, in all the region south and east of Dingle Bay.

The Dingle Beds.—In the Dingle Promontory, however, there is a total break and unconformability in the great mass of red rocks which intervene there between the Upper Silurian rocks and the Carboniferous Limestone. Beds of yellow and red sandstones, and red and green shales, there rise conformably from beneath the Carboniferous Limestone, with sandstones and conglomerates below them, making a total thickness of two or three (or perhaps four) thousand feet. These spread unconformably across the edges of other red sandstones, and shales, and conglomerates, many thousand (ten or twelve apparently) feet in thickness, which rest on the Upper Silurian rocks, with either an absolute conformity, or a close approximation to it. We have confined the term Old Red Sandstone to the upper mass, which seems to make a conformable base for the Carboniferous Formation, and given the temporary and provisional name of the "Dingle Beds" to the lower mass, which seems

to be more physically connected with the Upper Silurian rocks. We are still in doubt whether the lower portion of the red rocks in the Iveragh and Dunkerron promontory, south of Dingle Bay, are the "Dingle Beds" or not. There is a good deal of lithological resemblance between the rocks of the two promontories, but not a perfect identity. Some blood-red shales or slates, which are occasionally conspicuous in the promontory north of the Bay, do not appear, I believe, in that to the south of it. The thick massive grits, to which we have given the name of Glengariff Grits,* are, however, prominent in both.

In the colouring of the Geological Map of Ireland, however, I thought it most prudent simply to colour the two promontories according to the observed facts. In the Iveragh and Dunkerron promontory the upper red beds are certainly Old Red Sandstone; in descending from these we never met with any characters sufficient to enable us to run a lower boundary to this Old Red Sandstone, and we have therefore coloured all the rocks as belonging to that formation. In the Dingle promontory we got a very decided boundary between two unconformable groups, and have given a provisional colour to the lower group as the "Dingle Beds," confining the Old Red Sandstone colour to the upper group. (*See Explanations of Sheets* 160, &c., and *of Sheets* 182, &c.)

Fossils determined by Mr. Baily.—In two of the Explanations of our Maps—namely, that of Sheets 187, 195, and 196 (those which include Cork Harbour), and that of Sheets 192 and 199 (including the head of Bantry Bay), the fossils found in the Carboniferous Slate are discussed by Mr. Baily, and the species and localities catalogued in a way proposed by myself, which will be found to give a good deal of information in a very condensed and convenient form.

Contemporaneity of Carboniferous Slate and Carboniferous Limestone.—There will also be found the reasons which induced me lately to come to the conclusion that the Carboniferous Slate was absolutely contemporaneous with the Carboniferous Limestone; mud and silt being deposited in one part of the sea during the same time that limestone was produced in other parts of it, from the *débris* of the hard parts of marine animals, and especially from the growth of submarine forests of

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* In introducing the names "Glengariff Grit" and "Coomhola Grit," I have somewhat departed from the usage common among geologists, since I have used them in a lithological rather than a chronological sense. In each case they are peculiar kinds of stone, recognisable in hand specimens. I have never seen the exact variety of sandstone to which we have given the name of "Glengariff Grit," except in the Old Red Sandstone and Dingle beds of the south-west of Ireland. There is also a peculiar lithological character in the Coomhola Grits, which I have never seen except in the sandstones which lie in the Carboniferous Slate.

encrinites. I now believe that the Carboniferous Limestone and the Carboniferous Slate equally repose on the Old Red Sandstone, and were equally covered by the Coal-measures resting conformably upon them. The Diagram, Fig. 1, will show what I believe to have been the original relations of the rocks; but this must be taken as a mere diagram, and not as an attempt at a representation of nature, because; to say nothing of the distortion in length, the Carboniferous Slate becomes at least twice as thick as the Carboniferous Limestone. All the beds, both in this and all other geological sections, should be drawn as a mere assemblage of cakes thinning out and terminating in all directions, if it were wished to represent them as they are in nature.

Fig. 1.

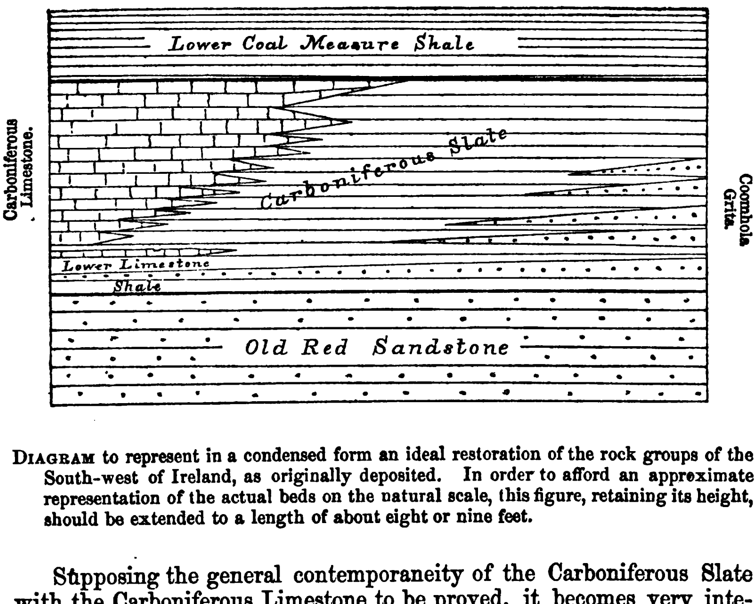

DIAGRAM to represent in a condensed form an ideal restoration of the rock groups of the South-west of Ireland, as originally deposited. In order to afford an approximate representation of the actual beds on the natural scale, this figure, retaining its height, should be extended to a length of about eight or nine feet.

Supposing the general contemporaneity of the Carboniferous Slate with the Carboniferous Limestone to be proved, it becomes very interesting to know how far the rocks of Devon and the Rhine agree with those of Cork.

NORTH DEVON. *Piltown and Marwood.*—In August, 1861, I arrived at Barnstaple, and spent five days in examining the country about it. I extract the following passages from my note-book, describing the first day's traverse from Barnstaple northwards:—

"On the road to Piltown dark grey slate with crinoidal rings, nearly horizontal. On first hill-top in Piltown black slate, with calcareous nodules and bands, and seams of fossils; dip south at 25°; cleavage dips south by east at 68°." "*Rhynchonella pleurodon* and *Fenestella antiqua* abundant; the character of the rock and mode of occurrence of the fossils precisely like the Carboniferous Slate of Cork.

"Going up the hill north of Bradford Mill, grey slates interstratified with thin brownish grits from one to eight inches thick, some very rusty-looking and ochreous; dip south, at 80° to 90°.

"Beyond (to the north of) that, dark blue soft slate again, in which the stratification was not determinable.

"For a mile to the north of that, little cuttings by the road sides, or bare rocks in the roads, showed dark blue or grey slate (black when wet), all apparently dipping south at high angles.

"All the minutest peculiarities of the rocks are precisely like those about Kinsale, Rosscarbery, or Bantry.

"In the lane running north-east, between Shankey Down and Fairleigh, dark blue slate, the bedding of which could only be determined by observing the bands of fossils. They dipped W. 20° S. at 30°, while the cleavage of the slate dipped south-south-east, at 70°.

"Small specimens of *Rhynchonella pleurodon* and stems of *Platycrinus* were abundant, together with small *Orthis* or *Chonetes*.

"In Prexford, and going down to Marwood, greenish and brownish sandstones in thick beds, and mingled clayey and sandy rock, like that about the Yellow Sandstone of the county of Cork, &c.; dip south-south-east at 60°.

"In the wood south of Marwood church one or two quarries in brown and greenish slates, sandstones, and gritstones.

"Some of the grits are so precisely like those of the Kinsale country, that it is really wonderful, especially a very peculiar grit, which I never saw before except in the Carboniferous Slate of Ireland. This is a fine-grained light grey grit, seamed all through with thin undulating surfaces of jet black, shiny, argillaceous matter, along which the grit has a tendency to break up into flat lenticular nodules. There are also brownish grits with a grey base, thickly sprinkled with brown dots, such as we call 'speckled grits' in Ireland. Some are much decomposed and quite brown, others black, breaking like rotten wood, and powdering everything about." "These grits are interstratified with hard, dark, sandy clay-rock, not cleaved into slate." "A thickness of fifty or sixty feet of these beds is exposed, all dipping south 10° west, at 40°; no fossils seen in them."

"Pale greenish-grey slate, with some dark blue bands, crop up about Marwood church, at high angles, from under these sandstones.

"Half a mile north of Marwood church (just south of the W. of Widdin, as engraved on the map), purple slates precisely like those of the Old Red Sandstone of Cork.

"Another half mile farther north, on Swinburn Down, a quarry shows purple, green, and yellow sandstone, very like the beds which form the Yellow (or Upper Old Red) Sandstone in West Cork; no plant remains or other fossils visible. The dip is south, at 80°."

This first day's traverse showed me that in North Devon there existed a series of rocks precisely identical with the rocks of the South-west of Ireland both in lithological and palæontological character; and that we had here the Old Red Sandstone below, and a great thickness of Carboniferous Slate above, with sandstones in the lower part of it, answering exactly to the Coomhola Grits of Ireland.

A subsequent examination of the country by Braunton, and round Baggy Point on the west, and by High Bray, and what is called in the map Span Head,* and Two Barrow Down, on the east, disclosed similar facts.

The red and green grits that show themselves on the coast about Vention, at the south side of Morte Bay, and the pale lilac grits alternating with grey or green, and sometimes with purple and liver-coloured beds, the grits thick and massive, and interstratified with bands of shale, all cleaved into slate, are precisely like the rocks that may be seen outside the mouth of Glengariff Harbour, or about Bearhaven, or other places in Bantry Bay; or about the Mizen Head, or Skull Harbour, or Toe Head, or Galley Head, or the Seven Heads, on the south coast of Cork.

Taken by itself, that might be of little significance; but on following the rocks round Baggy Point, I found a great series of beds above these red ones, precisely like the beds that lie above the red beds in the county of Cork; greenish and greyish sandstones and grits, interstratified with bands of grey and blue slate, until, after passing over a thickness of about 1500 or 1600 feet of such beds, blue and grey clay-slate alone appeared in long straight reefs and ledges in Croyde Bay, precisely as similar rocks show themselves in so many places along the indented coast of the South-west of Ireland.

A succession of beds of many hundreds of feet in thickness having the same variations of lithological type occurring in precisely the same order, and with similar minute lithological peculiarities, those beds being admittedly *about* the same geological horizon, can hardly be other than the same identical beds.

I must therefore believe that the rocks at Vention are genuine Old Red Sandstone, and that above them we have a great thickness of Carboniferous Slate, with the Coomhola Grits in the lower parts of it.

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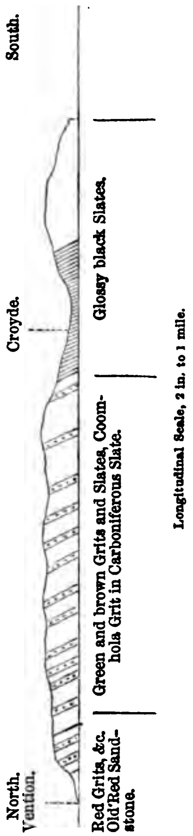
* The hill called Span Head on the Ordnance Map was not so called by the people of the country; and the map altogether was so very indifferent, as to make conclusions as to one's position quite uncertain. When the claims of Scotland and Ireland are quite satisfied, perhaps it may be considered the turn of England herself to have a really good map of the whole country.

Fig. 2.

Section from Morte Bay on the north, past the head of Croyde Bay on the south, looking east. The green Grits, &c., form Baggy Point, a mile or two west of the line of section.



But this conclusion does not rest upon lithological evidence only. At Braunton I was lucky enough to make the acquaintance of Mr. G. A. Symons, a retired Custom House Officer, who occupies his leisure in collecting fossils, so that I was enabled to purchase from him a collection that would have taken me months to form myself. Mr. Symons was good enough also to accompany me to the quarries where he had collected them, and from what I saw with him I had every reason to be satisfied with the accuracy of his statements as to the localities from which they had been collected.

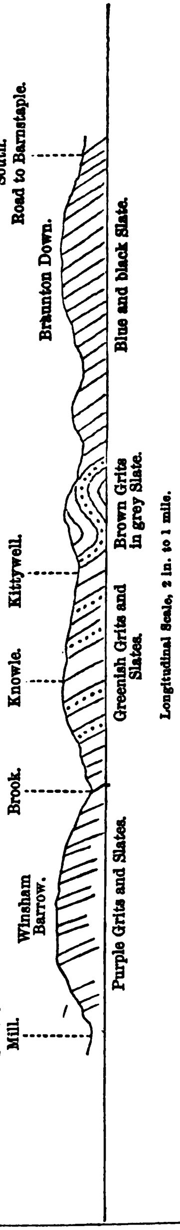
The little north and south valley, at the mouth of which the village of Braunton is situated, affords a pretty good section of the beds by means of a succession of quarries. On the hills on the east side of the village are quarries in beds of grit or sandstone, interstratified with blue slate containing many fossils, the dip of which is about S. 15° W., at 50° to 70°. The cleavage was a little irregular, but in one quarry was noted as perpendicular, striking east and west. Farther north, in the latitude of the little hamlet of Buckland, beds which must be somewhat lower dipped N. 10° E., at 30° or 40°, showing the existence of an anticlinal curve between those two places. There was here a large quarry of dark grey sandy slate and grit, with long stems of fossil plants, compressed by squeezing, precisely like those which occur in the slate rocks of the shore of Mr. Puxley's domain at Castletown Berehaven, in Bantry Bay.

There were also in the same quarries bands of brown sandstone six or eight inches thick, full of the casts of *Cucullæa trapezium,* the rock being often a mere congeries of the impressions of these shells. I think Mr. Symons called these quarries the Kittywell quarries, from the name of a place a little north of them.

Farther north, just north of a place called Knowle, on a new road, there is a large quarry in greenish and grey grits with green slates, which dip south by west at 70°. These are the same grits as those at Marwood, which strike thence in a straight line by Darracott to Baggy Point. They contained at this place a cast of a Curtonotus (of Salter), a small Bellerophon, and other fossils, and also part of a (Knorria or) Sagenaria.

Fig. 3.

Section along the east side of the Braunton Valley, looking east.



The next quarry to the north, at a distance of about a quarter of a mile, showed a purple slate (just like the slates in the Cork Old Red Sandstone), which dipped about south at 80°. Fig. 3 is a diagrammatic section along the east side of the Braunton valley.

Braunton Fossils.—The following is the list of the fossils which I procured from Mr. Symons, the species being determined by Mr. W. H. Baily:—

Plants.

Sagenaria* (Knorria) Veltheimiana.
Sternbergia.

Actinozoa.

Chætetes tumidus.
Petraia Celtica, more properly Cyathophyllum Celticum.
Pleurodictyum problematicum.

Polyzoa.

Fenestella antiqua. | Ceriopora gracilis.

Brachiopoda.

Athyris concentrica, and oblonga or planosulcata.
Chonetes Hardrensis.
Producta prælonga.
Orthis interlineata.
Rhynchonella cuboides, laticosta, and pleurodon.
Spirifera cuspidata, disjuncta, striata, and Urii.
Streptorhynchus crenistria.
Strophalosia caperata.
Strophomena analoga.

Conchifera.

Avicula Damnoniensis.
Aviculopecten nexilis, polytrichus, tesselatus, transversus.
Cucullæa amygdalina, Hardingii, and trapezium.
Cypricardia sp. | Nucula sp.
Modiolopsis sp. | Sanguinolites sp.

* This was from a place near Knowle, where the sandstones were beginning to become red.

Gasteropoda.

Acroculia vetusta.
Loxonema rugifera.

Heteropoda and Cephalopoda.

Bellerophon subglobatus.
Orthoceras undulatum.

Echinodermata.

Actinocrinus polydactylus and tenuistriatus.
Cyathocrinus pinnatus and variabilis.
Poteriocrinus sp.
Protaster, two species.
Rhodocrinus sp.

Crustacea.

Phacops granulatus and latifrons.

Ilfracombe Beds.—Of the beds still further north, which rise out below the red slates and sandstones, I cannot say much, as I only traversed them once, along the road from Barnstaple to Ilfracombe. I met, about five miles north of Barnstaple, with pale green grits and pale lilac and grey slates, the cleavage of which dipped south at 70°, not unlike those which appear in some of the anticlinal ridges of the county of Cork, where the Old Red Sandstone (all cleaved into slate) rises from underneath the Carboniferous Slate; and it appeared, certainly, as if the main dip of the beds was to the south, at high angles. On the road between Warmscombe and Wincham, however, pale green slate appeared to undulate towards the north, sometimes at as much as 30°, the cleavage still dipping south at 50°.

At Ilfracombe itself, grey, brown, and salmon-coloured sandy slates dip south, with contortions. Some of the smaller bands of bluish-grey slates are undistinguishable from those in the Carboniferous Slate, and do not resemble any which I remember to have seen among the slates of the Old Red Sandstone of Ireland. Nevertheless, except in this and in the absence of dark red or purple colours, the grits and slates are not very unlike those which the Old Red sometimes presents in the county of Cork, and some beds even reminded me of Glengariff Grits.

I did not see the trace of a fossil anywhere to the northward of the red band that runs from Morte Bay by Winsham Barrow, Mid Marwood, Muddiford, and thence to Span Head, and Two Barrow Down. Fossils, however, have been procured from Ilfracombe, Combe Martin, and Linton, some of them being of the same species as those from the Carboniferous Slate; and if it can be shown that the beds of the north coast are really below the red beds of Morte Bay, then North Devon will disclose facts which have no parallel in the South-west of Ireland.

I must say, however, that I do not feel perfectly satisfied, from what I saw, that the rocks about Ilfracombe and the north coast are really below the Old Red Sandstone beds of Morte Bay. In the paper by

Professor Sedgwick and Sir R. I. Murchison, "On the Physical Structure and Older Stratified Deposits of Devonshire," in vol. v. of the "Transactions of the Geological Society of London" (2nd series), the rocks are described as much contorted, and the section given shows the difficulty of deciding on this point, and also that a large thickness of rocks certainly rolls over and dips to the north. In the colouring of the section, indeed, this anticlinal curve and northern dip along the northern coast are confined to the lowest group, which is probably the "Morte slates" and the beds below them; but from the difficulty and obscurity of the ground, it seemed to me quite possible that the higher beds are also brought in. The fossils also found in the rocks of the north coast from Ilfracombe to Linton, as mentioned in that paper, and those described by Professor Phillips in the "Palæozoic Fossils of Devon and Cornwall," induce in my mind a suspicion that possibly the beds of Linton, Combe Martin, and Ilfracombe may belong to the Carboniferous Slate rolled in to the north by contortions, and somewhat different lithologically from those farther south.

The section given in Sir H. De la Beche's Geological Report does not afford any conclusive evidence against such an opinion, since it follows the line of coast, and shows numerous folds of the beds, and spaces where other contortions may exist, so that no very definite conclusions can be deduced from it.

I mention this suspicion, however, with diffidence, and merely put it forward as one of the points which it remains for future examination to put beyond doubt.

Devon Coal-measures.—Of the beds above the Carboniferous Slate I saw exposures in some of the quarries and cuttings from South Molton, by Swinbridge to Bickington and Bideford. They had many lithological resemblances to the Irish Coal-measures of Cork and Kerry. There are not in Ireland, however, any black limestones like those which occur near the base of the Devon Coal-measures. These black limestones and their associated beds are accurately described in De la Beche's "Geological Report," pp. 102 to 118. Some of the limestones are black and earthy, some rather a calcareous grit than true limestone; but others are quite crystalline, the crystals often showing a circular facet, with a dot in the middle, which betrays their crinoidal origin. The shales associated with them are often so carbonaceous as to stain the fingers. Near Hele I saw black shales weathering white, like those of Ballyheedy, near Ballinhassig, county of Cork, which contain Cœlacanthoid fish and Posidonomya.

In some places near South Molton I observed in the basal shales of the Coal-measures that peculiar banded character and iron-stained colour which is a striking feature in the lower Coal-measure shales (or slates) throughout the South of Ireland, from the county of Cork to the county of Dublin.

At the Culm pit now working near Bideford, and in the railway cuttings there, the impressions of Stigmaria and other common Coal-measure plants were abundant.

Altogether, judging by analogy with the Irish Coal-measures, I have no doubt of the so-called Culm-measures of Devon being of the age of the genuine Coal-measures of the rest of England, including the Millstone Grit as a mere subordinate member of those Coal-measures.

In the South of Ireland and in Devon the beds which contain the peculiar assemblage of fossils characteristic of the lower Coal-measures (or Millstone Grit) are all shales or slates.

This assemblage consists of the following species (see *Explanations of Sheets* 102 and 112, and the previously cited Explanations of the Irish Geological Survey Maps) :—

Calamites and other Plants.
Aviculopecten papyraceus and *variabilis.*
Posidonomya Becheri and *membranacea.*
Lunulacardium (sp.).
Goniatites sphæricus and var. *crenistria.*
Orthoceras Steinhaueri and *scalare.*
Fish scales and bones of the Genera *Cœlacanthus* (?) and *Palæoniscus* (?)

De la Beche, "Report," p. 102, insists on the difficulty of deciding on any boundary line between the "Carbonaceous Group" and that which he calls the "Grauwackè Group," and on the absence of any mark of erosion on the lower group before deposition of the upper, or any unconformity between the two. The patches which rest on the Carboniferous Slate of Cork that are supposed to belong to the Coal-measures, are equally inseparable from them by any want of conformity, or any marked lithological character. On the hypothesis that the Carboniferous Slate of Cork and Devon is the equivalent of the Carboniferous Limestone, this conformable gradation is only what might be expected. The difficulties alluded to in p. 131 of the Report are entirely cleared up by the hypothesis.*

So long as the term Grauwackè was applied to the Carboniferous Slate, or that group was supposed to be older than the Carboniferous Limestone, the occurrence of Coal-measure plants in the "Carbonaceous rocks" of Devon had to be explained by other hypotheses, which, to say the least, are not less violent than the one here suggested.

The section given in Fig. 4 will show with approximate accuracy the lie of the beds on a north and south line through Marwood and Pilton, across the flats and estuary of Barnstaple (which are there about a mile wide), to the village of Hele. Feeling certain of the beds about Hele being the true Coal-measures, both from palæontological evidence and from their similarity to the Coal-measures of the South of Ireland, and equally sure that the beds about Swinham Down are the Old Red Sandstone, I must conclude from this section only that the intermediate beds are contemporaneous with the Carboniferous Limestone.

* I use the term hypothesis for the sake of those who may still doubt it. I have myself no doubt at all that it is the true interpretation of the facts.

Fig. 4.

Section through Marwood and Pilton, from the Old Red Sandstone to the Coal-measures south of Barnstaple.

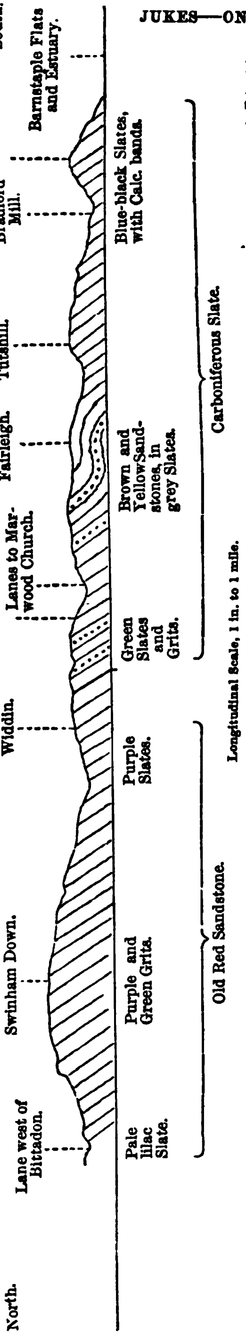
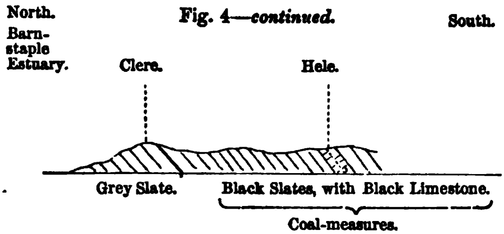


Fig. 4—*continued.*



Longitudinal Scale, 1 in. to 1 mile.

General Results.—The great paper on the "Physical Structure of Devonshire," &c., by Professor Sedgwick and Sir R. I. Murchison, in the 5th vol. of the "Transactions of the Geological Society of London," contains conclusions which were a great advance upon those previously taken for granted, and gave us the first approximation towards placing the "Older Stratified Deposits" of that district in their true chronological position. The arguments adduced in it that—"Rocks identical in geological position may entirely change their lithological structure as they pass from one country to another," and that "a change of structure implies a change of conditions during the time of the deposits, and such a change might greatly modify the forms of life" ("Transactions of the Geological Society," vol. v., p. 699), are perfectly sound, and are the very arguments which I would myself urge. The authors of that paper, however, applied them to the hypothesis of a change in the Old Red Sandstone, and I to one in the Carboniferous Limestone. They suppose that the Old Red Sandstone changes into the grey slates of Devon, and also that the Carboniferous Limestone passes into the lower Culm-measures. The hypothesis which I propose leaves the Old Red Sandstone out of the question for the present, and supposes simply a change from Carboniferous Limestone into Carboniferous Slate (which is as likely as into the Culm-measures), and leaves the Coal-measures unchanged, not indeed from their South Welsh type, but from the type which they present throughout the South of Ireland, where they rest upon 2000 or 3000 feet of Carboniferous Limestone.

In a note to page 700, the authors express a hope that their classification may throw light on the structure of the South of Ireland. The

result of the Geological Survey of Ireland, however, both by Sir R. Griffith, and by that of the Irish branch of (what I may perhaps be allowed to designate as) Her Majesty's Geological Survey of the United Kingdom, is to point to the South of Ireland as the typical district to which both British and Continental geologists must look for the basis of the true chronological classification of those which have been called Devonian rocks.

It is true that in Ireland we have neither the "Stringocephalus Limestone," nor the Black "Culm-measure limestones." If we class the latter with the Coal-measures, all we can say is, that they are wanting in the South of Ireland, where all the calcareous matter is below the Coal-measures.

I do not at present venture to offer any opinion on the place of the Stringocephalus Limestones; but I do venture to ask, whether there is distinct proof that they are not in the Carboniferous Slate? Can the limestones of Combe Martin and the fossiliferous beds of Ilfracombe and Linton be clearly shown to lie below that group of red slates and sandstones which rises out in Morte Bay, and admittedly rolls over and dips to the north somewhere? Or can the Stringocephalus Limestones of South Devon be shown to lie below anything that can be identified as Old Red Sandstone? Are not the South Devon rocks a mere expansion of the Carboniferous Slate of North Devon, with a change in the *Fauna* depending on difference of *province*, just as the difference between the Fauna of the Carboniferous Slate and the Carboniferous Limestone is one depending chiefly upon *habitat*?

I do not pretend at present to answer these questions, but I would venture to suggest that they have never yet been definitely asked, nor have data been yet collected sufficient to give them a satisfactory answer.

Comparative List of Fossils found in the Rocks of the South-West of Ireland and North Devon.

In drawing up this list of fossils I have adopted the plan used in the "Explanations" of the Irish maps, giving first a numbered list of all the localities from which the fossils were procured, and then appending to each species the numbers of the localities in which it was found. This plan shows the geographical distribution of the species, and the frequency or rarity of occurrence of each, at a glance; and it is easy from it to pick out the number of species found at any one locality—number 30, for instance—as the eye immediately detects the presence or absence of that number under each species. Any amount of detail, too, as to the exact description of any locality, can then be introduced into the list of localities.

The authorities for the specific designations are—for Ireland, Mr. Baily's lists in the Explanations of the Irish Maps, Sheets 187, &c., and 192, &c.,—the species of Brachiopoda having been previously submitted to Mr. Davidson's inspection; for England, the lists in Sedgwick and Murchison's paper, in Phillips's "Palæozoic Fossils," Salter's paper

on the "Upper Old Red Sandstone" ("Quarterly Journal Geological Society of London," November, 1863); Morris's Catalogue, and Davidson's Devonian Brachiopoda, in the "Palæontographical Society's Publications;" and the list of fossils procured from Mr. Symons, of Braunton, determined by Mr. Baily.

In drawing up this comparative list I have been advised and assisted by my colleague, Mr. W. H. Baily; for without a professed palæontologist to appeal to, it would be impossible to avoid mistakes.

When fossils occur as mere casts, which is their usual condition in slates and grits, it must often be difficult to determine whether they are specifically different from similar fossils in limestone, or not. This difficulty is increased when the fossils are distorted either by irregular pressure, such as often is apparent in fossils derived from limestone that has been but little altered, as well as from other rocks; or still more when they are distorted in a *quasi*-regular and symmetrical manner, as constantly occurs in rocks traversed by slaty cleavage.

It is not to be wondered at that many erroneous determinations of species have thus been arrived at by able palæontologists; nor is it unlikely that many identical species of shells may still pass under different names in our lists, according to differences in the circumstances of their preservation. When to these circumstances are added the original variation in the size and growth of species of shells according to circumstances that surrounded them during life (their *habitat*, as the botanists phrase it), accuracy of specific determination becomes still more difficult.*

There is, however, another influence which renders lists of fossils very ticklish things to handle, and that is the reform, or at all events the change, which is continually going on in their generic and specific designations.

The old friend of my youth, the *Producta depressa* of the Upper Silurian rocks, passed for many years under the *alias* of *Leptæna*, but has now for some time taken that of *Strophomena*. Shells that I at all events cannot distinguish from the old species, *Producta scabricula*, I find designated as *Strophalosia caperata*, or by some persons *Strophalosia scabricula* (see Salter's paper, "Quarterly Journal Geological Society, London," vol. xix., p. 491). The *Spirifera crenistria* of Phillips's "Yorkshire," is called an *Orthis* in the "Palæozoic Fossils," an *Orthoid* species of *Leptæna* in Morris's Catalogue, an *Orthisina* by Sandberger, but is now decided by Mr. Davidson to be a *Streptorhynchus*. An almost equally puzzling variety of designation takes place among the Conchifera, nor are other classes of fossils much more stable in their nomenclature.

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* We may also add the influence of those intermediate varieties between species and species which the opponents of Darwin's theory confidently demand from geologists, and proof of the existence of which, I think, geologists may as confidently present to them in the long lists of synonyms given in palæontological works, those synonyms being largely made up of what appeared to be distinct species to one set of men, while others class them as varieties of one species.

I do not wish to assume the tone of a censor, or to say that these changes are not improvements, or that it is not necessary that palæontological nomenclature should pass through this transitional metamorphosis before it reaches a stage of comparative permanence; but perhaps I may be allowed to express a hope that we are now approximating to that stage, and that lists of fossils may no longer be written in a language which a few years renders obsolete, as is already the case, not only with the lists in Sedgwick and Murchison's paper, but even with those in Phillips "Palæozoic Fossils," and in Morris's "Catalogue of Fossils."

I have not included among the Devon localities those of Ilfracombe, Combe Martin, or Linton, or any of those in South Devon, but only those lying between the neighbourhood of Baggy Point and that of Dulverton for the Carboniferous Slate, and those between Bideford and Bampton for the Coal-measures, adding to the first the locality of Petherwin in Cornwall.

For the Irish Carboniferous Slate, the localities extend from the shores of Cork Harbour, where some Carboniferous Limestone still exists above the Slate, to the western headlands of Bantry Bay and Kenmare Bay. No species is mentioned which has been found only in the Carboniferous Limestone; nor are any species given on the sole authority of the lists in Sedgwick and Murchison's paper, except the plants from Bideford.

List of Localities.

The localities in Devon and Cornwall are in Roman numerals, to distinguish them from the Irish, and show the species common to the two districts at a glance. The only Cornish locality mentioned is Petherwin, No. XII.

Old Red Sandstone Localities.

1. Kiltorcan, near Ballyhale, in the parish of Knocktopher, county of Kilkenny. The lower beds of this part of the Old Red Sandstone consist of conglomerate resting upon Granite and Lower Silurian slate, and it all dips gently to the west under the Carboniferous Limestone, with a few intervening beds of Lower Limestone Shale between the two. The rock in which the fossils lie is a yellowish-green, fine-grained flagstone, interstratified with bright red slates. Its place is probably 100 or 200 feet below the Lower Limestone Shale, or perhaps a little less or more, the ground not affording the means for a more precise measurement.
2. Tallow Bridge, in the county of Cork, a cutting on the road side, a little east of the bridge, in the topmost beds of the Old Red Sandstone, about its junction with the Lower Limestone Shale (see Fig. on p. 22 of Explanation of Sheet 187 of Irish Maps).
3. Tivoli Villa, Lower Glanmire road, east of the city of Cork; a quarry which is now built over, near the uppermost beds of the Old Red Sandstone, in a greenish stone, like that of Kiltorcan, but traversed by slaty cleavage.

4. Gokane Point and Castlehaven, in the county of Cork, on the shore west of Toe Head, and south-east of Tracarta, in the upper part of the Old Red Sandstone, in beds very similar to those of No. 3, and not unlike those at Kiltorcan, except that they are *all* traversed by slaty cleavage.

4 *a.* Coolownig, half a mile south of Collorus, on the south side of Kenmare Bay, on the road to Castletown Bearhaven.

Carboniferous Slate Localities.

v. Baggy Point, the promontory south of Morte Bay, the extreme western headland of that part of North Devon lying north of Barnstaple or Bideford Bay. The rocks are chiefly grey or greenish grits and brown and yellow sandstones, interstratified with slates. They correspond to the Coomhola Grits of West Cork, which occur in the middle and lower portion of the Carboniferous Slate.

vi. Croyde, a village on the south side of Baggy Point at the head of a little bay, the shores of which show reefs of glossy blue or black slate, the precise equivalent of the more purely slaty portion of the Carboniferous Slate of West Cork.

vii. Saunton, a hamlet, a mile and a half to the E. S. E. of Croyde.

viii. Braunton, a large village, about a mile and a half east-south-east of Croyde, or six miles west-north-west of Barnstaple; the parish includes the upper part of the Old Red Sandstone, and all the Carboniferous Slate except the very topmost beds.

ix. Marwood, a village, four miles east of Braunton and three north of Barnstaple. The same beds of sandstone (lying in the Carboniferous Slate) strike from Baggy Point, by Darracott and Kittywell in Braunton, to Marwood.

ix. *a.* Sloly, a hamlet, three miles north by east of Barnstaple, said by Professor Sedgwick to show sandstones in slates, on the strike of the Marwood beds.

x. Pilton, a village on a small hill, about half a mile north of Barnstaple. The beds are a glossy blue or black slate, with calcareous bands, such as may be seen near Ringabella, outside Cork Harbour, in many parts of Bantry Bay, and throughout the country between them. They are near the upper part of the Carboniferous Slate group.

xi. Brushford, a village, about two miles south of Dulverton, and about twenty-four miles east-south-east of Barnstaple.

xii. Petherwin, a village, about three miles south-west of Launceston, in Cornwall. The rocks are chiefly a pale greenish-grey slate, sometimes calcareous, and containing bands of actual limestone, not altogether so similar to the Carboniferous Slate of Cork as are those of North Devon, but containing many of the same fossils, and undoubtedly part of the same formation. Some blue-black slates were also observed.

13. Bellmount Lower, near Crookstown, seventeen miles west-south-west of Cork; sandstones in the Lower Limestone Shale.

14. Kilpatrick; in Carboniferous Slate.
15. Callatrim, south of Mishells House, a mile and a half north of Bandon; in Carboniferous Slate.
16. Annaghmore, near Cross Barry; a Coomhola Grit in the Carboniferous Slate.
17. Ballinhassig, near the station, about seven miles S. S. W. of Cork; a grit in the Carboniferous Slate.
18. Killaminoge; Coomhola Grits in the Carboniferous Slate.
19. Castlelands, north of Enniskeen, near parochial school; Coomhola Grit.
19*a*. Larah, near Tinker's Cross-roads, two miles W. N. W. of Bandon; in Carboniferous Slate.
19*b*. Coolfadda, a mile and a half west of Bandon, on the road to Enniskeen.
20. On the road to Brookfield, a mile and a half south-east of Bandon; Coomhola Grit.
21. Danganbeg, near Barleigh Bridge, about three miles south of Bandon; grey slate.
22. Cloghane, half a mile west of Rockhouse, between Inishannon and Ballinadee; Coomhola Grit.
23. Lahern, west of Templeavarra Church, south of Inishannon.
24. Mellifontstown, near Ballyvrin Cottage, a mile and a half E. N. E. of Dunderrow; dark grey slate.
25. Ballyfouloo, road-cutting in the glen east of Raffeen House, a mile west of Monkstown, in Cork Harbour; Lower Limestone Shale, consisting of Grits and Slates, at least 1500 feet thick, but with Carboniferous Limestone over them.
26. Monkstown, half way between Monkstown and Raffeen House, west side of Cork Harbour; same beds as 25.
27. Queenstown, cuttings near the Market-house; same beds.
28. Coolkirky, a small quarry in a field, on hill top, on south side of lane to Coolkirky House, between Monkstown and Kinsale; Coomhola Grit.
29. Kilnaglery, near Brookfield, a mile south-east of Carrigaline; Coomhola Grit.
29*a*. Ballea, two miles west of Carrigaline; thick slates, with Carboniferous Limestone above them.
30. Belgooly, near Springmount, in the townland of Lybe, half a mile N. N. W. of Belgooly, which is two miles north by east of Kinsale; dark-grey slate.
31. Gortacluggy, shores of Oysterhaven, opposite Mountlong Castle; grey and black slate.
32. Ringroe, on the shore near Flat Head; black slate with calcareous bands.
33. Ballycottin Bay, to the east of Cork Harbour, on shore; Lower Limestone Shale, like 26 and 27.
34. Timoleague, to the west of the town, which is six miles east of Clonakilty; Coomhola Grit, in Carboniferous Slate.

35. Scartagh, opposite the Union Workhouse, half a mile north-east of Clonakilty; grey slate.
36. Rocksavage, in Ballinglanna Cove, south-east of Clonakilty, on shore; grey and black slate.
37. Dunworly Bay, on the west side; Coomhola Grit, in Carboniferous Slate.
38. Sevenheads Bay, on shore in the townland of Ballymacraheen; Coomhola Grit, in Carboniferous Slate.
39. Old Head of Kinsale, on the shore east of the old Signal Tower; grey slate.
40. Kinsale Harbour, Sandycove; grey slate.
41. Kilkeran, four miles east of Rosscarbery, about a mile and a half north of Kilkeran Lough; Coomhola Grit, in Carboniferous Slate.
42. Duneen Point, west side of Clonakilty Bay; Coomhola Grit, in Carboniferous Slate.
43. Dirk Bay, on shore north of the Coastguard Station; Coomhola Grit, &c.
44. Galley Head, on shore at Castlecove; Coomhola Grit, &c.
45. Bealad, four miles west of Clonakilty; Coomhola Grit, &c.
46. Benduff, two miles north of Rosscarbery; Coomhola Grit, &c.
47. Ahills, two miles west of Union Hall, near Shepperton; Coomhola Grit, &c.
47*a*. Toe Head; Carboniferous Slate and Coomhola Grit, &c.
48. Abbeystrowrey, a mile and a half north-west of Skibbereen; both grits and slates.
49. Mohanagh, two miles north-west of Skibbereen; Coomhola Grit, &c.
50. Killaveenoge West, three miles east of Dromdaleague, on road to Reavouler Bridge, and some other places in the neighbourhood; both slates and grits.
51. Baurnahulla, a mile south-east of Dromdaleague; grey slate.
52. Maunvough, four miles east of Bantry, half a mile south-east of Trawlebane Bridge; grey slate.
53. Seehanes, on the east side of River Ilen, three-quarters of a mile south of Castle Donovan; grey slate.
54. Ballyhalwick, on the road, a mile and a half east of Dunmanway; Coomhola Grit.
55. Shehymore, about the foot of Shehy Mountain; grey and black slates, below Coomhola Grit, and but little above the Old Red Sandstone.
56. Cousane, near the road, half a mile north of Shehybeg Mountain; grey slate.
57. Dromleigh, on the road, about half a mile south-west of Bantry; slates and grits.
58. Relane Point, two and a quarter miles south-west of Bantry; slates and grits.
59. Gorteanish, on the east side of Evanson's Cove, on the north shore of Dunmanus Bay; Coomhola Grit, &c.

60. Reenydonagan Point, two and a half miles north of Bantry; grey slate, with calcareous bands.
61. Reenadisert, on the north-west side of Ballylickey Bridge, three miles north of Bantry; grey slate, with some calcareous bands.
62. Whiddy Island, in Bantry Bay, the north-east point of it; black slate.
63. Ardnaturrish (*more* and *beg*), the shore on the eastern side of the approach to Glengariff Harbour, in Bantry Bay; the typical section of the Coomhola Grit, part of the Carboniferous Slate.
64. Coorycommane, the hill between the entrance to Glengariff Harbour and the Glen of Coomhola; same beds as on Ardnaturrish shore.
65. Coomhola Glen, north of Snave Bridge, at the north-east corner of Bantry Bay; same beds as above.
66. Bear Island, Bantry Bay; numerous localities are here grouped together which are given separately in Explanation of Sheet 192, &c., of Irish Maps; they are all on the northern side of the island, in slates and grits.
67. Black Ball Head—under this designation numerous localities along the shore from the western entrance of Bearhaven past Black Ball Head and White Ball Head, are here grouped together (see Explanation, *loc. cit.*); the Coomhola Grits, interstratified with grey and black slate, strike in full force along this shore.
68. Kilcatherine, the shore about the western extremity of the south side of Kenmare (river or) Bay; Coomhola Grits, in Carboniferous Slate.
69. Ardgroom, various places about Ardgroom Harbour, on the south side of Kenmare (river or) Bay; same beds as preceding.
70. Collorus, the part of the shore to the eastward of Ardgroom; same beds as the preceding.
71. Kilmakilloge, shores of Kilmakilloge Harbour, south side of Kenmare Bay.
72. Lehid, shores about the small harbour of Lehid, north-east of Kilmakilloge; beds probably higher, with calcareous bands.
73. Cloonee, the neighbourhood of Ardea Castle and the Cloonee Loughs, to the eastward of Lehid; Coomhola Grits, in Carboniferous Slate.

Coal-measure Localities.

LXXIV. Swinbridge, a village about eight miles E. S. E. of Barnstaple; black limestone in black slates.

LXXV. Venn, a hamlet, between Barnstaple and Swinbridge; black slates.

LXXVI. Coddon Hill, about two miles south by east of Barnstaple; black slates.

LXXVII. Bampton, a small town, six miles north of Tiverton; black limestones in black slates.

LXXVIII. Westleigh, a hamlet, one mile south of Holecombe Regis, and seven miles north-east by east of Tiverton.

LXXIX. Bideford; the black shales and slates from which culm is extracted in the neighbourhood of that town.

80. Ballyheedy, two miles south of Ballinhassig, between Cork and Kinsale; black carbonaceous shale or slate.
81. Skehanagh, a place a little west of the preceding; same beds as preceding.
82. Meadstown and Ballinphelic, immediately south of Fivemilebridge, between Cork and Kinsale.
83. Lispatrick, on the shore of Courtmacsherry Bay, at the commencement of the promontory of the Old Head of Kinsale; black carbonaceous shales or slates.

NOTE.—The Irish localities mentioned are in small ill-defined patches of black shales and slates, which rest on the Carboniferous Slate, but resemble in the kind of rock the Coal-measure shales or slates which lie above the Carboniferous Limestone further north, and contain similar fossils.

OLD RED SANDSTONE FOSSILS.

Plants.

Adiantites (Cyclopteris) Hibernicus, 1, 2, 4.
Filicites lineatus (linear plants), 4.
Sagenaria (Knorria) Veltheimiana (*Goep.*), Lepidodendron minutum (*Haughton*), 1, 2, 4, 4*a*, VIII.
,, Kiltorkensis (Cyclostigma Kiltorkense of *Haughton*), 1, 4.
Sphenopteris Hookeri (*Baily*), 1.
,, Humphresianus (*ib.* MS.).
Plant stems undetermined, 1, 2, 4, 4*a*.

Undetermined plant stems (some of them Stigmaria-like roots) were also seen in many other localities in the Old Red Sandstone.

Conchifera.

Anodonta Jukesii,* 1, 3, 4.

Crustacea.

Eurypterus Scouleri† (?) *Hibbert*, 1.

Pisces.

Asterolepis, ? sp., 1.
Bothriolepis, ? sp., 1–4.
Coccosteus decipiens, ? 1.
Glyptolepis microlepidotus, 1.
,, ? elegans, 1.
Pterichthys,‡ ? sp., 1.

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* A fine specimen of this shell was also procured by Mr. Doran from the Old Red Sandstone near Clonmel.

† A few fragments only, but sufficient to leave no doubt as to its *genus*, were found in this locality.

‡ Mr. Baily believes that all these genera are represented by the fish scales, teeth, and jaws from the Kiltorcan quarry. Of the occurrence of the genera Coccosteus and Glypto-

Fossils of the Carboniferous Slate.

[Note.—The species which occur in the Carboniferous Limestone of the British Islands, according to Morris's Catalogue, have L before them.]

Plants.

Filicites lineatus, 25, 27, 37, 48, 52, 56, 63, 64, 66, 68, 73.
Sagenaria (Knorria) Veltheimiana,* IX.*a*., 35, 56, 68, 71.
Sphenopteris Humphresianus.

Fragments of undetermined plants, like those of the Old Red Sandstone, some of them perhaps torn leaflets of Ad. Hibernicus, also occur in the lower part of the Carboniferous Slate of Ireland at many other localities. Stigmaria-like roots also occur frequently.

The plants described by Professor Sedgwick from the Coomhola Grits of the Sloly quarries in Devon, are said by Professor Lindley to contain either a *Stigmaria* or a *Lepidodendron*. Mr. Salter speaks of them as *Knorria*, and of their occurrence in green grits in other localities in Devon. Parts of the very same stems at Tallow Bridge, in Ireland, have the appearance of a *Lepidodendron*, while other parts are more like some variety of *Sigillaria*. They are, in the opinion of Mr. Baily, mostly referrible to the genus *Sagenaria*, Brongn.

Pieces of the stem of this plant, which I found in the red rocks north of Braunton, were precisely identical with some which we got in Ireland.

It is probable that all the species of plants are common to the Old Red Sandstone and the Carboniferous Slate.

Actinozoa.

L. Alveolites (Chætetes) depressa, 60.
Amplexus tortuosus, XII.
L. Chætetes tumidus, VIII., 19*a*, 38, 45, 54, 58, 60, 67, 72.
L. Cladochonus crassus, 30.
Cyathophyllum (Petraia†) Celticum, VIII., XI., XII., 14, 16, 19*a*, 24, 30, 60, 67.
L. ,, cæspitosum, XII.
Fistulipora cribrosa,‡ X., XI.
Pleurodictyum problematicum, VIII., 15, 18, 19*a*, 19*b*, 22, 24, 30, 58, 72.

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lepis there is no doubt. The fish remains occurred—well preserved, but mostly detached—in a little seam, three inches thick, which on the last occasion of our working the quarry was followed out for some distance without the occurrence of any large connected group of scales in their natural position.

* This plant, or those called *Knorria acutifolia* and *confluens* by *Dunker* and *Mayer* (perhaps identical species) occurs in Carboniferous Slate also in Dromleigh, on the road about half a mile south-west of Bantry. W. H. B.

† To this species are referrible other species of "Petraia," and of the genus "Turbinolopsis" of the "Pal. Foss." of Phillips. W. H. B.

‡ Referred to "Manon," in Phil. "Pal. Foss."; but a Fistulipora according to Morris.

Polyzoa.

Ceriopora gracilis,[1] VI., VIII., X., XI.
L. „ rhombifera, 21, 30, 32, 33, 35, 50, 52, 63, 68.
L. Fenestella antiqua,[2] VI., VIII., X., XI., 15, 19*a*, 27, 30, 32, 52, 55, 58, 60, 61, 63, 66, 67, 68.
Glauconome pluma,[3] 60, 63, 66.
L. „ bipinnata,[3] VI., X., XI.
L. Polypora laxa,[4] VI., 60, 67.

Brachiopoda.

L. Athyris ambigua, 15, 17, 18, 21, 22, 23, 24, 30, 36, 40, 49, 58, 63, 66.
„ concentrica,[5] V., VIII., X., XI., XII., 36, ? 60, ? 63.
L. „ lamellosa,[6] 53.
L. „ planosulcata,[7] VIII.
L. „ Royssii, ? 60, ? 63.
„ seminalis (n. s., Baily), 63, 66.
Atrypa desquamata, XII.
L. Chonetes Hardrensis, VIII., 36, 60, 67.
„ plicatus, X. XI.
Cyrtina heteroclita,[8] 60.
L. Discina nitida, 29.
L. Lingula mytiloides, 56, 58, 61, 63, 66, 68.
L. „ squamiformis, 33, 56, 63, 66.
Orthis calcar, X.
„ interlineata, VI., VIII., XI., XII.
L. „ Michelini,[9] 28, 30, 33, 36, 52, 53, 63, 66, 67.
L. Producta prelonga,[10] (?) V. VIII.
L. „ scabricula, X., XI., 30, 35, 60, 67.
L. „ semireticulata, 30.
„ n. s., 60.
„ sp. undeterminable, 53, 55.

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[1] Called Millepora in "Pal. Foss." Mr. Baily believes that *C. gracilis* and *rhombifera* are the same species.

[2] With this species Mr. Baily would unite *Retepora flabellata* and *tenuifila* of Phillips's "Yorkshire," and *F. plebeia* of M'Coy, which occur in the Carboniferous Limestone.

[3] Mr. Baily believes these also to be the same species.

[4] Called Fenestella in "Pal. Foss.," and also in Salter's paper.

[5] Given by Phillips as *Spirifera decussata* (Morris).

[6] The *Spirifera squamosa* of Phillips's "Yorkshire" (ib.).

[7] Davidson unites *A. oblonga* with this species.

[8] This specimen was examined by Mr. Davidson, who decided with little doubt that it belonged to this genus and species. The beds in which it occurs at Reenydonagan, in Bantry Bay, are near the top of the Carboniferous Slate, and abound in *Phillipsia pustulata*, with other species common in the Carboniferous Limestone generally.

[9] This is the *Spirifera filiaria* of Phillips's "Yorkshire" (Morris).

[10] Mr. Baily is of opinion that this species is merely another variety of *Producta semireticulata*, var. *Martini*.

Rensselæria stringiceps[1] (?), 30.
Rhynchonella cuboides, VIII.
,, laticosta, V., VIII.
L. ,, pleurodon, V., VI., VIII., X., XI., 14, 17, 19*a*, 20, 22, 26, 29, 30, 32, 34, 35, 36, 37, 38, 42, 45, 47, 48, 49, 50, 52, 55, 58, 60, 66, 67, 68, 72.
,, pugnus, ?47*a*.
L. Spirifera cuspidata, VIII., 14, 18, 19*b*, 29, 46, 47*a*, 51, 58, 67, 68, 72.
,, disjuncta (?)[2] V., VIII., XII., 33, 36, 55, 60, 61, 64.
,, (Spiriferina)? laminosa, 14, 60, 66.
,, lineata, XII., 33, 60, 66, 67, 68.
L. ,, pinguis, 29*a*.
L. ,, striata, VIII., 16, 18, 19*b*, 28, 29*a*, 30, 32, 33, 36, 46, 47*a*, 49, 60, 66, 67, 68.
L. ,, Urii,[3] VIII., X., XI., XII., 36, 55.
L. Spiriferina cristata (*Schloth*), 17, 30, 60, 61, 67.
,, var. octoplicata.
L. Streptorhynchus crenistria, VIII., 15, 18, 19*a*, 19*b*, 21, 29*a*, 27, 29, 38, 50, 51, 55, 58, 60, 66, 67, 68, 72.
Strophalosia caperata,[4] VI., VIII., X., XII.
L. Strophomena analoga, VIII., IX., X., 67, 68.
L. Terebratula hastata, 19*a*, 10*b*, 22, 29, 58.
Rhynchonella subdentata, XII.

Conchifera.

Avicula Damnoniensis, VIII., IX., 13, 14, 19*a*, 25, 28, 26, 27, 30, 34, 37, 39, 40, 41, 42, 45, 47, 49, 50, 51, 52, 56, 57, 59, 63, 64, 65, 66, 67, 68, 69, 70, 71, 73.
,, exarata, XII.
,, subradiata, XII.
,, undetermined sp., 25, 26, 55, 70.

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[1] Mr. Davidson detected among the Irish specimens submitted to him from this locality some elongated oval casts, approaching in shape to this form. It occurs at Ilfracombe.

[2] According to Mr. Davidson, the so-called species which have been named *Archiaci*, *Barumensis*, *calcarata*, *distans*, *extensa*, *gigantea*, *grandæva*, *inornata*, *Lonsdalei*, *Murchisonianus*, *protensa*, *Verneuillii*, are all synonyms, or varieties of *S. disjuncta*. He holds it to be decidedly distinct from *S. striata*, some varieties of which, however, are certainly so much like some varieties of *S. disjuncta*, that none but a very practised eye can perceive the difference. See the plates of the two species in Davidson's "Brachiopoda."

[3] Mr. Davidson had some doubts as to this species from the Irish localities; but Mr. Baily feels confident of the correctness of the identification. The Devon localities are from Morris's Catalogue.

[4] Mr. Baily and Mr. Salter had previously named some of the Irish specimens as belonging to this genus and species; but Mr. Davidson could not satisfy himself of its occurrence among those specimens which we submitted to him, and believed those which resembled *Strophalosia caperata* to be *Producta scabricula*.

Aviculopecten alternatus, XII.
,, arachnoideus, XII.
L. ,, arenosus? 37, 58.
,, granulosus, XII.
,, nexilis, VIII., X., 37.
C. M. ,, papyraceus,[1] 35.
L. ,, plicatus, ? 45.
,, polytrichus, VIII., XI.
L. ,, tesselatus, VIII.
,, transversus, VIII., X., XI., XII.
,, undetermined sp., 35, 39.
L. Axinus (Cypricardia) deltoideus, XII.
,, n. s. (figured in Explanation of Sheet 192), 49.
,, undetermined sp. 35, 37, 43, 65.
Cardiola retrostriata, XII.
Ctenodonta (Pullastra) elliptica, XII.
Cucullæa amygdalina,[2] VIII., IX., 19.
,, angusta, IX.
,, depressa, IX.
,, Griffithii[3] (*Salter*, MS.), 47, 49.
,, Hardingii, VIII., IX., 20, 23, 27, 28, 30, 39, 41, 63, 70, 72.
,, trapezium,[2] IX.
,, unilateralis,[2] IX.
Curtonotus centralis, 19.
,, elegans,[4] ? VIII., ? X., 19, 20, 28, 41, 63, 65, 66.
,, ,, var. elongatus, 19, 20, 24, 37, 39.
,, ,, var. rotundatus, 19, 27, 30, 37, 58, 65, 67, 69.
Cypricardia Phillipsii,[5] V.
,, undetermined sp., 39, 65, 67.
L. ? Dolabra securiformis, 66.
,, undetermined sp., 17, 22.
L. Leda attenuata, 58.
Modiola amygdalina, ? XII.
L. ,, MacAdami, 13, 26, 27, 28, 34, 35, 36, 40, 41, 43, 46, 47, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73.
Nucula latissima, X.
,, lineata, V.
,, plicata, V.

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[1] Almost the only known instance of the occurrence of this species anywhere, except in the Coal-measures. J. B. J.

[2] The species marked thus are probably synonyms of *C. Hardingii*. W. H. B.

[3] This fine species is figured in our Explanation of Sheet 192, &c.

[4] Mr. Salter mentions the occurrence of shells of this genus in the Pilton group. I saw casts of some north of Braunton. I have supposed them to be of this species solely because it is the most abundant species.

[5] Occurs in the Lower Limestone Shale, in two localities, in the county of Cork.

Nucula tenuiarata (Sandberger), 67.
,, n. s. (figured Explanation, 192, &c.), 47.
,, undetermined sp., 13, 15, 17, 18, 22, 32, 33, 34, 37, 41.
Orthonota (Cypricardia) semisulcata, XII.
Pterinæa spinosa, XII., ? 49.
,, ventricosa, XII.
Pullastra antiqua, IX., X.
L. ,, bistriata, ? 60.
Sanguinolaria ? sulcata, XII.
Sanguinolites complanatus, X.
,, liratus, X.
L. ,, oblongus, ? 63.
L. ,, plicatus, 43, 48, 66, 67, 68, 71.
L. ,, transversus, 43, 44.
,, sp., VIII., 14, 30, 33, 39, 42.
L. Sedgwickia bullata, ? 26.

Gasteropoda.

L. Acroculia (Capulus and Pileopsis) striata, ? 22.
L. ,, vetusta, VIII., 60.
Dentalium, sp., 39.
L. Euomphalus pugilis, 58.
,, serpens, XI., XII.
,, undetermined sp., 67.
Loxonema nexilis, XII.
L. ,, rugifera, VIII., XI.
,, sinuosa, XII.
L. ,, tumida, XII.
,, undetermined sp., 13, 47, 49, 67, 70.
Macrocheilus neglectum, ? XI.
,, undetermined sp., 19*a*, 66, 67.
L. Murchisonia angulata, XI., XII.
Natica meridionalis, V.
,, nexicosta, XII.
L. ,, plicistria, ? 51.
,, undetermined sp., 13, 14, 17, 18, 46, 66, 69, 71.
L. Patella retrorsa, ? 55.
Pleurotomaria aspera, X., XII.
,, cancellata, XI., XII.
L. ,, expansa, V.
,, gracilis, V., XI.
,, undeterm. sp., 18, 22, 37, 39, 40, 51, 58, 66.
Vermetus (Pleurotomaria) antitorquatus, XII.

Heteropoda.

Bellerophon bisulcatus, XII., 39, 47.
L. ,, decussatus, ? 58.

L. Bellerophon striatus, 22, 23, 50, 51, 67, 69.
,, subglobatus, VIII., IX., X., 13, 19*a*, 26, 31, 34, 36, 37, 46, 47, 49, 50, 51, 54, 57, 58, 60, 67.
,, trilobatus, ? (probably a form of bisulcatus), XII.
L. ,, Urii, V., X., 13.
,, undeterm. sp., 15, 17, 22, 40.

Cephalopoda.

Cyrtoceras rusticum, XII.
Clymenia fasciata, XII.
,, lævigata, XII.
,, linearis,[1] XII.
,, plurisepta, XII.
,, sagittalis, XII.
,, striata, XII.
,, valida, XII.
,, undulata,[1] XII.
Goniatites biferus, XII.
,, bisulcatus, XII.
Goniatites insignis, (?)[2] XII.
,, linearis, XII.
L. ,, vinctus,(?)[2] X., XII.
Nautilus megasipho,[3] XII.
L. Orthoceras cinctum, XII., 15.
,, cylindricum, X.
,, imbricatum,[4] IX.
L. ,, fusiforme,[5] XII.
,, laterale,[6] XII.
L. ,, lineolatum, VI.
,, striatulum, XII.

L. Orthoceras undulatum, VIII., XII., 25, 26, 35, 42, 50, 51, 66.
,, undetermined sp., 15, 22, 24, 28, 30, 32, 37, 39, 44, 52, 54, 58, 67, 68.

Echinodermata.

L. Actinocrinus polydactylus (probably identical with triacontadac.), VIII., 32.
L. ,, tenuistriatus, P. F., VIII., X.
L. ,, triacontadactylus, 52, 53, 55, 61, 63, 66, 67, 68.
,, variabilis,(?)[7] 15, 16, 28.
Adelocrinus hystrix,[8] XI., (?)61.
L. Archæocidaris Urii, 67.
Cyathocrinus macrodactylus, XI.
L. ,, pinnatus, VIII., (?) 31.
L. ,, planus, 36, 61, 67.

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[1] Morris unites *linearis* with *undulata*, which latter Salter does not mention in his list. W. H. B.

[2] Morris makes *insignis* a synonym of *vinctus*. Salter retains *insignis*, does not mention *vinctus*, but gives *bisulcatus*, which is not mentioned by Morris. W. H. B.
From the figure in Sedgwick and Murchison's paper, it appears to be the same as *G. Henslowi*, and they refer it to that species.

[3] Is this the young of another species? See plate in "Pal. Foss."

[4] *Orthoceras imbricatum* is the name given also to an Upper Silurian species.

[5] Morris makes *O. fusiforme* a *Poterioceras*.

[6] Morris refers this to *undulatum;* Salter retains it.

[7] These are probably identical with *Actinocrinus triacontadactylus*, according to Mr. Baily.

[8] These are probably identical with *Platycrinus*, according to Mr. Baily.

L. Cyathocrinus variabilis, (probably the same as Actin. variab.), VIII., 15, 16, 27, 28, 29*a*, 37, 40, 43.
Palæaster, n. s., VIII.
L. Pentremites ovalis, XI.
L. Platycrinus lævis, (?)67.
,, undetermined sp. (joints of the genus Platycrinus are of very frequent occurrence), 31, 32.
Protaster,* n. s., VIII., two sp.; 36, one sp.
L. Poteriocrinus and Rhodocrinus seem to be both represented among the Braunton specimens, according to Mr. Baily.

Crustacea.

Leperditia† (Cypridina) subrecta, 25, 26, 58, 65.
Phacops granulatus, VIII., XII.
,, latifrons, VII., VIII., X., XI., XII.
L. Phillipsia pustulata, 60, 62, 67.
Trimerocephalus lævis, XI.

Pisces.

Holoptychius scales, V.

COAL-MEASURE FOSSILS.

Plants.

Asterophyllites foliosa, LXXIX.
Calamites arenaceus, LXXIX.
,, undulatus, LXXIX.
Cyperites bicarinata, LXXIX.
Neuropteris cordata, LXXIX.
,, gigantea, LXXIX.
,, heterophylla, LXXIX.
,, Loshii, LXXIX.
Nöggerathia dichotoma, (?)80, 81.
Alethopteris (Pecopteris) lonchitica, LXXIX.
Pecopteris muricata, LXXIX.
,, Serlii, LXXIX.
Poacites cocoina, LXXIX.
Sphenopteris acuta, LXXIX.
,, latifolia, LXXIX.
Stigmaria,‡ sp., LXXIX.

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* One of the species from Braunton appears to be identical with that from Rock-savage, near Clonakilty. W. H. B.

† Parts of the Lower Limestone Shale and of the Carboniferous Slate are so crowded with these minute bodies, that they might be well called Cypridina-slate, like the Cypridinen-schiefer of Germany. J. B. J.

‡ The list of Bideford plants given above will be found in the Appendix of Sedgwick and Murchison's paper. To the additional occurrence of Stigmaria markings in abundance I can myself bear testimony, inasmuch as it is impossible I could be mistaken in identifying things with which I am so familiar. J. B. J.

Plant stems in undeterminable fragments were also seen at 80, 81, and 82.

Conchifera.

Aviculopecten papyraceus, 81.
Posidonomya Becheri, including the varieties called *lateralis*, *membranacea*, and *tuberculata*, LXXIV., LXXV., LXXVII., 80, 81, 82, 83.
„ vetusta (?), 82.

Cephalopoda.

Goniatites carbonarius (?).*
„ sphæricus, var. crenistria, LXXIV., 80, 81, 83.
„ mixolobus,† LXXVI., LXXVIII.
„ spiralis,† LXXVII.
„ spirorbis,† LXXVII.
Orthoceras cylindraceum, LXXIV., LXXV.
„ scalare, 80, 81.

Pisces.

Cœlancanthus sp., 80, 81.
Palæoniscus sp., 81.

I would wish in a few words to direct attention to the main conclusions resulting from this comparative list.

In the true Old Red Sandstone of Ireland no fossils have yet been procured which are not of land and fresh water origin, except the fish (which may be fresh water), and the fragments identified with Eurypterus. No fossils have been procured from the Old Red Sandstone of North Devon, except parts of Sagenaria, or Knorria, as it is sometimes called, and those identical with those common in Ireland.

Of the Carboniferous Slate fossils the plants seem to be the same as those found in the Old Red Sandstone. This would be a fact in favour of considering the true Old Red Sandstone as belonging to the commencement of the Carboniferous Period.

The animal fossils of the Carboniferous Slate show many species common to Ireland and England, and those the most abundant and important species, as *Cyathophyllum* (*Petraia*) *Celticum*, *Pleurodictyum problematicum*, L.‡ *Fenestella antiqua*, L. *Polypora laxa*, *Athyris concentrica*, L. *Chonetes Hardrensis*, L. *Producta scabricula*, L. *Rhynchonella pleuro-*

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* This is mentioned in Sedgwick and Murchison's paper. It was probably from the Coal-measures near Barnstaple, and from the figure might be an imperfect specimen of *G. crenistria.*

† These may perhaps all belong to the preceding species, according to Phillips's own descriptions in the "Pal. Foss." *G. mix.*, and *G. spiralis* and *spirorbis* have "Dev." attached to them in Morris's Catalogue; but the localities given are, as every one admits, in the Culm-measures, and not in any Devonian formation.

‡ The L prefixed serves to distinguish the known Limestone species.

don, L. *Spirifera cuspidata*, *disjuncta*, L. *striata* and L. *Urii*, L. *Streptorhynchus crenistria*, L. *Strophomena analoga*, *Avicula Damnoniensis*, *Cucullæa Hardingii*, *Curtonotus elegans*, L. *Acroculia vetusta*, *Bellerophon subglobatus* and L. *Urii*, L. *Orthoceras undulatum*, L. *Actinocrinus polydactylus*, *Adelocrinus hystrix*, L. *Cyathocrinus variabilis*. This list might have been largely increased, had it not been for the caution exercised by Mr. Baily in leaving under the head of many genera "species undetermined," which could not be certainly identified with the forms figured by Phillips, or others, though they were most probably the same species.

The palæontological identity of the rocks of the two countries is moreover shown by the fact, that many species which have hitherto only been found in one of the two districts also occur elsewhere in the Carboniferous Limestone; so that we can apply the axiom, that "things which are equal to the same thing are equal to one another."

Of Carboniferous Limestone fossils which occur in the Carboniferous Slate of Ireland, but have not yet been identified from that of Devon, we have *Alveolites* (*Chætetes*) *depressa*, *Cladochonus crassus*, *Ceriopora rhombifera*, *Athyris ambigua*, *lamellosa*, and ? *Royssii*, *Lingula mytiloides* and *squamiformis*, *Orthis Michelini*, *Producta semireticulata*, *Spirifera laminosa*, *lineata*, and *pinguis*, *Spiriferina cristata*, *Terebratula hastata*, *Aviculopecten arenosus* and *plicatus*, *Dolabra securiformis*, *Leda attenuata*, *Modioli Mac Adami*, *Pullastra bistriata*, *Sanguinolites oblongus*, *plicatus*, and *transversus*, *Sedgwickia bullata*, *Acroculia striata*, *Euomphalus pugilis*, *Natica plicistria*, *Patella* (?) *retrorsa*, *Bellerophon striatus*, *Actinocrinus triacontadactylus* and *variabilis*, *Archæocidaris Urii*, *Cyathocrinus planus*, *Platycrinus lævis* ?, and *Phillipsia pustulata*.

Of Carboniferous Limestone species found in the Slate of Devon, but not yet identified in that of Ireland, we have *Cyathophyllum cæspitosum*, *Ceriopora gracilis*, *Glauconome bipinnata*, *Athyris planosulcata*, *Aviculopecten tesselatus*, *Axinus* (*Cypricardia*) *deltoideus*, *Loxonema rugifera*, and *tumida*, *Murchisonia angulata*, *Pleurotomaria expansa*, *Goniatites vinctus*, *Orthoceras fusiforme* and *lineolatum*, *Actinocrinus tenuistriatus*, *Pentremites ovalis*.

When we add to these Carboniferous Limestone species those marked L. in the list of species common to the two slate districts, the palæontological argument for the contemporaneity of the rocks of both districts with the Carboniferous Limestone seems to me as strong as could possibly be expected in such various deposits.

The occurrence of Trilobites of the genus *Phacops* in the slates of Devon is perhaps the fact most calculated to induce palæontologists to assign a higher antiquity to those deposits; but there is no reason why that genus should not have continued to exist during the Carboniferous Period, where the nature of the sea bottoms and surrounding circumstances were favourable to its longevity.

NEIGHBOURHOOD OF COBLENTZ.

In the sixth volume of the "Transactions of the Geological Society," Professor Sedgwick and Sir R. I. Murchison published a paper "On the Older Deposits of North Germany and Belgium," in which they lay down the basis for a reform in the previously received ideas respecting the age of those deposits, and sketch out the relation between the Rhenish rocks and those of Cornwall and Devon.

They have been followed by many other writers, both British and Continental, among whose works I would especially mention that of the brothers Guido and Fridolin Sandberger on the Rhenish Slate System of Nassau ("Die Versteinerungen des Rheinischen Schichtensystems in Nassau"), and Von Dechen's new and admirable Map of Rhenish Prussia, now coming out.

My own personal knowledge of the rocks of the Rhine and Moselle country is confined to hasty observations on a few quarries and cliffs on the banks of those rivers. I passed, however, two or three weeks at Coblentz last autumn; and though I was unable, from temporary ill health, to do more than a little casual work, I believe it will be worth while to record the impressions which that left on my mind, as they might afford a starting point for some fellow-labourer.

In the quarries on the road side by Laubach and Kapellen, two or three miles south of Coblentz, I was struck with the resemblance of the rocks to the Carboniferous Slate and Coomhola Grit of Ireland. The same minute lithological peculiarities (which can no more be recognised from description than that resemblance between two persons which we designate as a family likeness) struck me here, which had formerly impressed me in North Devon.

Some of the beds, however, were not like any I knew in the Carboniferous Slate of Ireland or Devon; and on the black shining surfaces of some other beds I observed the impressions of Posidonomya in great abundance.

If, therefore, it be possible that the Carboniferous Slate is to be found here, it is also possible that beds belonging to the Coal-measures rest upon it, as they do in Ireland and Devon, with no very definite boundary between the two.*

It can hardly, perhaps, be mentioned as a corroboration of this idea, but is still worth noting, that in two places I found thin seams of actual coaly matter sufficiently carbonaceous to stain the fingers, like that which would be called a "coal smut" in Staffordshire, or a "coal rod" in Ireland. One of these places was about a mile north of Kapellen,†

* I by no means mean to assert that Posidonomya is peculiar to the Coal-measures, as we get it abundantly in the more earthy (calpy) parts of the Carboniferous Limestone of Ireland.

† Mr. F. J. Foot, of the Geological Survey of Ireland, having made a trip to this district last June (1865), informs me that a two-foot coal was formerly worked near Kapellen; he also brought thence some plant impressions—vague, but just like those often seen in the Irish coal-measures.

and the other on the side of the road which winds up to the Karthauserberg, by a little footpath, with steps, going up to the first fort there.

The Karthauserberg is a promontory of rocky high land between the rivers Rhine and Moselle, which is not much more than a mile across about Laubach, and runs for about two miles north of that. Its summit is a plain at a height of 300 or 400 feet above the rivers, with steep slopes in all directions towards them, except on the south, where the ground rises still higher towards the Kuhkopf, which is a minor eminence of that hilly region which is called the Hundsruck to the south of the Moselle, and the Eifel to the north of that river.

The northern termination of the Karthauserberg slopes to a plain about a mile wide, which is but little above the level of the rivers, and has evidently been formed by their detritus, their junction having travelled down stream about a mile, in consequence of the accumulation of that detritus under the lee of the Karthauserberg.

The rocks are all violently contorted, dipping in various directions at high angles, but their general inclination seemed to me to be from the high land towards the Rhine on the east, and towards the Moselle on the west. This led me to speculate on the possibility of rocks representing the Old Red Sandstone being found about the axis of the anticlinal, in the direction of the Kuhkopf; and it was accordingly with no small interest that on my last drive across the upland plain of the Karthauserberg I came, at the margin of the higher land, on some quarries in red and yellow sandstone, precisely resembling the upper part of the Old Red, or that which has been called the Yellow Sandstone, of Ireland. These are on the Moselle side of the high land, about half a mile north-east of the village of Lay. The beds dip west and north-west at 55° or 60°, and certainly rise from under the dark slates and grits which appear in the cliffs above the river.

The occurrence of this red and yellow sandstone precisely in the direction where I was speculating on the possibility of its existence, but with little expectation of finding it, may be no more than a chance coincidence. It is, however, one that makes it worth while for any one, who may have the opportunity, to examine the ground about the Kuhkopf more particularly, and see whether there is really any mass of rocks resembling the Old Red Sandstone, and where that mass runs to.*

This investigation would have the greater interest if Mr. Sharpe's identification of the lower subdivision of M. Dumont's "Système Eifelien" with the Old Red Sandstone of England should turn out to be correct. In Mr. Sharpe's paper on the "Classification of the Palæozoic Formations given in Dumont's Maps" ("Quarterly Journal Geological Society, London," vol. ix., 1853, p. 23), will be found an account

* Mr. F. J. Foot informs me that red and yellow sandstones show themselves on the north side of the Kuhkopf summit, the surface being covered with their angular *debris*; but he could not find any section in them.

of this "Système," from which it appears that it consists of the Eifel limestone above, the Eifel fossiliferous schists in the middle, and a group of red sandstones and conglomerates below. This would exactly agree with the Cork sections, where, however, the limestone is the ordinary Carboniferous Limestone. If the identification of the red sandstones and the *Mur du Diable* conglomerate with the Old Red Sandstone, by MM. Rozet, C. Prevost, Delanow, and others, and Mr. Sharpe's support of it, be correct, it will follow that the rocks above are Carboniferous, their fossils differing from those of our Carboniferous rocks, perhaps because they belong to a different Carboniferous *province* from those of Great Britain.

Dumont placed his "Systèmes Ahrien" and "Coblentzien" below the Old Red Sandstone, depending solely, I believe, on palæontological evidence, which may after all be modified by space as well as by time, and thus point to a geographical difference instead of a chronological one.

If we can trace out an Old Red Sandstone base for the Coblentz rocks, it will be a strong confirmation of the opinion I ventured to state in the notes to Mr. Davidson's "Devonian Brachiopoda," p. 43, that the uppermost bed of the "Old Red Sandstone was in existence before the deposition of any of the beds containing marine fossils, to which the name of Devonian has been given;" and that all those beds are mere expansions of the Carboniferous Slate of Ireland and North Devon, and therefore, like it, merely geographical variations of the Carboniferous Limestone.

River Drift of the Karthauserberg Summit.—Before leaving the Karthauserberg, I would direct the attention of geologists to the sands and gravels which lie strewed over the upland plain, and the angular blocks of rock lying scattered about it, belonging to rocks which must be sought *in situ* higher up the respective river valleys. It is evident that the junction of the rivers once took place at this level; and, looking up their respective valleys, the lines of terrace at that level may be seen for some miles in each direction. The flat at the northern foot of the Karthauserberg is an exact reproduction of the flat at the top, formed by the rivers at their present levels, similar sands and gravels, and I believe similar blocks, being strewed over it.* If the country were now to undergo slow elevation, the rivers would begin to cut their beds more rapidly; and eventually the Coblentz flat would be

* In Murray's "Handbook" is the following passage:—"The breaking up of the frost is sometimes attended with danger to the town of Coblentz. In the spring of 1830, the ice on the Moselle came down while the Rhine was still frozen over, and being forced on by the current, while there was no outlet for its discharge, was raised into vast heaps near the junction of the rivers, so as to overtop the stone bridge near the Moselle and the quays along its banks. . . . The water of the Moselle rose so high as to break over the tongue of land on its left bank, threatening destruction to the village of Neuendorff, whose inhabitants took to flight, and it even floated *up the Rhine on the top of the ice as far as Boppart* (ten or twelve English miles). *The fields between the two rivers were covered with ice, and all communication cut off.*"

left above them, with steep slopes on each side of it, just as the Karthauserberg is now.

Ehrenbreitstein Rocks.—On the eastern side of the Rhine the rocks have a general resemblance to those of the Karthauserberg, though I was not so much struck with minor lithological resemblances to beds which I knew in Ireland and Devon.

The Rock of Ehrenbreitstein is made of grits, sandstones, and slates, which dip to the north-west at angles of 60° or 70°. In the little valley of the Mühlthal, at the back of the town of Ehrenbreitstein, a pretty good section may be seen in a series of quarries in beds which rise from underneath those on which the fortress stands. At the mouth of the Mühlthal valley the dip is north-west at 10°; the beds then flatten and roll over, so as to dip south-east at 70°, and then rise again in that direction at angles of 50° and 60°.

I only happened to discover fossils in one locality in a little abandoned quarry on the left-hand side of the road to Niederberg, about half a mile out of Ehrenbreitstein. The rock here was crowded with fossils, and the true stratification was only to be discovered by observing the layers of fossil shells. The rock, a green softish sandstone, splits into irregular plates along lines which are nearly horizontal, and which I took at first for the stratification of the rock, until I observed the real bedding by means of widely-spread layers of fossils, a few inches apart, and dipping north-west at 80°, when I perceived that the splitting of the rock must be due to cleavage.

The fossils procured from this quarry were named from Sandberger by Mr. Baily, and belonged to the following species:—

Chonetes sarcinulatus.	Spirigerina reticularis.
Spirifera macroptera.	,, lepida.

Phacops laciniatus.

The latter was a very fine specimen, and when cleaned was found to be much superior to any figured by Sandberger.

The species did not appear to be numerous, though the individuals were in immense abundance.

Collections of Fossils.—Two gentlemen of Coblentz have collections of the fossils of the neighbourhood, viz.:—Herr Geheimrath Zeiler, and Herr Handtmann, Postmaster, and were so obliging as to exhibit them to me.

There is a fine collection of fossils also in the Museum of Natural History at Bonn; but unfortunately they are arranged zoologically instead of stratigraphically, so that their geological significance could only be arrived at by a longer examination than my time allowed of.

The Work of the Brothers Sandberger.—In the map attached to the Sandbergers' work all the rocks of the neighbourhood of Coblentz* are coloured as belonging to the "Spiriferen-sandstein," and the whole system is classed into,

* In the margin of Von Dechen's new map the rocks about Coblentz are also called "Coblenz-schichten," and "Alterer Rheinische Grauwacke" of F. Roemer.

III. *Upper Group.*

5. Posidonomyen-schiefer.

II. *Middle Group.*

4. Cypridinen-schiefer.	3. Stringocephalen-kalk.

I. *Lower Group.*

2. Orthoceras-schiefer.	1. Spiriferen-sandstein.

I believe that the red sandstones which I saw on the southern border of the Karthäuserberg rise from beneath the Spiriferen-sandstein, in which Sandberger includes all the rocks immediately round Coblentz. If those red rocks turn out to be true Old Red Sandstone, it will follow that all these groups belong to the Carboniferous period. I should be inclined provisionally to consider it probable that the Lower and Middle groups of Sandberger should be massed together as the representative of the Carboniferous Slate, the Spiriferen-sandstein being, perhaps, the representative of the Coomhola Grit part of that group. I should look upon the subdivisions of the Carboniferous Slate (whether they be sandstones or limestones, and whatever may be their thickness) as of only local value and importance, and upon the variations in the names of their fossils as arising partly from the different names given to the same species, partly from real *variations* in the *species*, arising either from difference of *habitat*, or difference of *province*, and partly from the coming in of *different species* and *different genera*, depending on the same circumstances.

Should this speculation turn out to be well founded, it will probably follow that the Upper Group, the Posidonomyen-schiefer, will be found to be the representative of the bottom part of the true Coal-measures, that in which the local group of the Millstone Grit lies in the North of England.

On comparing the list of species given in the work of the Sandbergers with the list previously given in this paper, I find the following analogies between them.

Of Carboniferous Slate fossils the Sandbergers enumerate, as found in one of their four lower groups:—Among the Actinozoa, *Amplexus tortuosus, Cyathophyllum* (*Lithostrotion*) *cæspitosum,* and *Pleurodictyum problematicum;*—among the Polyzoa, *Polypora laxa;*—among the Brachiopoda *Athyris* (*Anoplotheca*) *lamellosa, Cyrtina* (*Spirifera*) *heteroclita, Producta subaculeata* (if this be, as I should suppose, a mere variety of *P. scabricula*), *Rensselleria* (*Rhynchonella*) *stringiceps, Rhynchonella pugnus, Streptorhynchus* (*Orthisina*) *crenistria, Strophomena* (*depressa*) *analoga, Terebratula elongata;*—among the Conchifera, *Cardiola retrostriata, Dolabra*(?) (*Isocardia*) *securiformis,* and *Nucula tenuiarata;* among the Heteropoda, *Bellerophon decussatus,* and the species called *trilobatus;*—among the Cephalopods, *Goniatites biferus* and *mixolobus;*

and among Crustacea, *Phacops laciniatus* and *latifrons*. Of Coal-measure fossils they give among the plants *Nœggerathia dichotoma* and *Stigmaria ficoides*;—and among the animals *Goniatites crenistria*, and *Orthoceras scalare*, as found in their Posidonomyen-schiefer.

The agreement in species, therefore, of the fossils of the Continental and British localities is as great, perhaps, as could be expected, when we take into account two things—first, that all the fossils have not been examined by the same individual, and that the difference in the nomenclature may be the result, to a very large extent, of what the astronomers call the *personal equation*; second, the influence of geographical distribution, or the difference in the *province* of the two Faunæ. When it is recollected that, according to M. Barrande's "*Parallèle entre les depôts Siluriens de Bohême et Scandinavie*," contemporaneous beds contain multitudes of species of Trilobites without a single species common to the two districts of Bohemia and Scandinavia, the amount of the specific identity of the fossils between these two Carboniferous Slate districts of Britain and the Rhine will appear great. If we compare the peculiar assemblage of genera, and especially of those genera of which fossils are most numerous, the resemblance between the Faunæ of the two districts becomes still more striking. Some resemblance may also be traced in a wider analogy, in the appearance, namely, of large bivalve shells (Conchifera) in the rocks of the two districts, although those of one region belong to the genus *Grammysia*, and those of the other to *Cucullæa*.

Conclusion.—The conclusions I have formed are two: first, that it was a mistake to include under one designation the Old Red Sandstone and the beds containing marine shells to which the name Devonian has been applied; secondly, that these latter are merely geographical representatives of the beds commonly known as the Carboniferous deposits, and chronologically are identical with them. Plainly as I have stated these opinions, however, I hold them as opinions formed solely by observation of facts, more or less clearly seen, to be modified or abandoned as soon as facts of a different tendency can be observed by myself, or adduced by others.

XVIII.—Further Notes on the Classification of the Rocks of North Devon. By J. Beete Jukes, M.A., F.R.S.

[Read Dec. 8, 1865.]

In the month of September last I was able to make another hasty visit to North Devon, with the object of continuing the comparison of the rocks there with those of the South-west of Ireland, and especially of examining the rocks of Lynton and Ilfracombe, which I had not previously seen.

With this object in view, I carefully reperused the paper in the 5th volume of the "Transactions of the Geological Society of London,"

by Professor Sedgwick and Sir R. I. Murchison, "On the Physical Structure of Devonshire." To whatever extent I may now feel myself compelled to differ from the authors of that paper in some of their views, let me here record my admiration of their graphic descriptions of the external features and internal structure of the country, and the bold and masterly conceptions they formed of it—conceptions which could only have resulted from a laborious and patient examination of the whole district of Devonshire and its borders. I must also acknowledge that any one who confines his attention to Devonshire will feel convinced, not only of the accuracy of their descriptions of the rocks, but of the correctness of their classification of them into several successive groups. There is nothing to be seen in Devon to lead any one to suspect that the apparent order of superposition of these rock groups is not their real order. The general dip of the rocks is to the south. These rocks are very well seen in the cliffs of the north coast, and in the ravines of the brooks which run out on to the north coast. As we trace these brooks up, however, towards the watershed of the country (which is not more than four or five miles distant), these ravines rapidly close in, and become shallow *valleys*, so that near the watershed the exposures of rock, whether natural or artificial, become very few. After crossing the watershed, however, the southern brooks begin soon to cut their valleys into deep ravines and glens, and exhibit corresponding sections of the rocks again. It unfortunately happens that, where the crest of the country running westwards from Exmoor strikes out upon the west coast in Morte Bay, the rocks do not form cliffs upon the sea shore, being backed by large and lofty sandhills, behind which the ground rises, with smooth grassy slopes, into a down. This is called Pickwell Down; and the high ground running eastward from it forms a succession of gently undulating heathery moorlands, or downs, for thirty or forty miles into the country. The summits of these round-topped, smoothly-sloped hills rise to heights varying from 1000 to 1400 feet above the sea. It often happens that no exposure of rock larger than a small wayside quarry is to be seen on these moorlands for three or four miles in every direction, and yet it is along this very central band of high ground that I believe the key to the structure of the country is to be sought, and probably sought in vain.

Had there been a clear coast section along Morte Bay, or a sufficient exposure of rock across the line of downs that run from Pickwell Down to Dulverton Common and Haddon Down, the structure of North Devon would not have remained an unsolved problem till the present day. As it is, I believe that problem to be not only unsolved, but that its solution is not possible by anything to be observed within that country itself; and the facts observable there must be interpreted by the knowledge acquired in some other district, where the same rock groups are more fully displayed, and their real order of superposition can accordingly be more certainly determined.

One reason for thinking the apparent not to be the real order of succession of the rock groups springs from the examination of Devon

itself; and that is the extraordinary thickness they must possess on the commonly received hypothesis.

The distance from Lynton to the Coal-Measure boundary, near South Molton, is about fourteen miles in a straight line, measured directly across the strike. The rocks both along this line and everywhere else have a prevailing dip to the south, with a few minor undulations or contortions. The inclination is slight on the north coast, but increases as we go south to a very high angle.

Mr. Weaver, whose accuracy of observation no Irish geologist would be inclined to question, divides the rocks of North Devon into eight groups, thet wo uppermost of which—his (7.) Wavellite Schists and limestones, and his (8.) Culmiferous Shale—belong to the Coal-measures, the six others being the rocks since called Devonian. These, he says, form one *consistent consecutive* series, and he divides them into—1. Foreland Sandstone; 2. Lynton calcareous slate; 3. Trentishoe quartzy slates and sandstones, including the Combe-Martin limestone; 4. Morte slates; 5. Wollacombe sandstones, flags, and slates; and, 6. Trilobite slates; and he describes the angle of dip as increasing towards the south from 20° to 80°, the strike being from 10° to 15° N. of W. and S. of E., true bearings.*

But, if we allow the width of this apparently consecutive series to be reduced one-third by the effect of contortion and undulation, and assign a mean angle of inclination of only 30° to a width of 50,000 feet of consecutive beds, we get a total thickness of about 25,000 feet. It seems to me impossible to allow any further reduction to this thickness, if we suppose the beds of North Devon to be really superimposed on each other in a regular order of succession. And it must be observed, that even then we do not reach their base, so that an indefinite addition has to be made for beds hidden by the waters of the Bristol Channel. This result is one that requires a comparison with some other district, where the same beds are exposed, either for correction or verification.

We have such a district in the South-west of Ireland, and the hypothesis I now offer for the interpretation of the North Devon section is based solely on the experience acquired by myself, and my colleagues of the Geological Survey in the southern counties of this country. I believe that the county Cork and the adjacent parts of Kerry must be taken as the typical district for the classification of the Devonian rocks, and that the grouping of the rocks of the South of Ireland, resulting from the labours of Sir R. Griffith and Her Majesty's Geological Survey, must form the model for the grouping of the same beds in other countries.

I do not, of course, mean to assert that the rock groups of other countries must necessarily be the same as those of Ireland; but I certainly must maintain that, as the rocks of Ireland are clearly shown,

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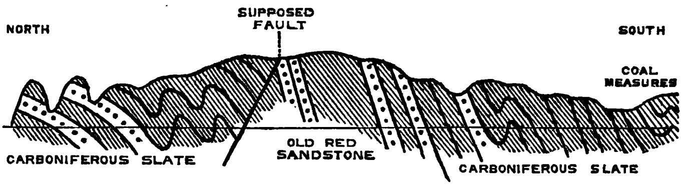
* See "Proceedings of the Geological Society of London," vol. ii., p. 589; paper read January 3, 1838.

and their order of succession can be observed in many localities, that order must be presumed to be the one which prevails in Devonshire, and in Western Europe generally, in all places *where no good reason can be shown to the contrary.*

It happened that Devonshire was described before the South-west of Ireland, and described by masters in our science. Had those describers however, been previously acquainted with the structure of the South-west of Ireland, they would have had reason to suspect that the apparent order of superposition in Devonshire was not the true one, and would doubtless have interpreted the sections in North Devon by the light of their previous Irish experience. Any one who has gained this experience will, I believe, agree with me in the ideas I have formed respecting the structure of North Devon. I shall not, on the other hand, be at all surprised, if any one without this experience, who looks solely to North Devon itself, declines to accept them.

My hypothesis is briefly this—that a great fault, with a downthrow to the north, strikes from the northern corner of Morte Bay, about east and by south, all across North Devon, somewhere near the villages of West Down, Bittadon, East Down, Challacombe, about a mile south of Simonsbath, and thence onwards in the same course.

The diagrammatic section in fig 1 will express in a general way, without reference to any particular line of country, what I believe to be the true structure of the district between the British Channel and the latitude of Barnstaple and South Molton.



Immediately south of the line of fault above mentioned, the country, wherever I have examined it, from Morte Bay to Dulverton, shows a great thickness (from 3000 to 7000 feet) of rocks which are identical in character with the Old Red Sandstone of Ireland, and precisely like what much of that of South Wales would be if it were sufficiently indurated, and traversed by slaty cleavage.

This Old Red Sandstone dips south at a high angle, and passes under dark grey and black slate identical in character with the Irish Carboniferous slate, and that dips south under a great thickness of other rocks equally identical with the Irish Coal-measures (see p. 115). But to the north of the line of the supposed fault above mentioned there is a great succession of other rocks also dipping south, and appearing, therefore, to pass under those which I have called Old Red Sandstone. There is no place, so far as I could learn by my own search, where the actual junction between this Old Red Sandstone and these apparently lower rocks

is to be seen, neither can I find any such place described by any other observer. Where all the rocks dip to the south, the natural conclusion is, that the southern rocks are the higher, and that the rocks farthest north rise up from beneath all the rest. According to the observable facts, therefore, the rocks on the north coast of Devon, about Lynton, should be the lowest group; and all these rocks—those, namely, of Lynton, Combe Martin, Ilfracombe, and Mortehoe—should dip under those rocks which I have called the Old Red Sandstone above.

But I found, to my surprise, that the rocks about Lynton were precisely identical in lithological characters with the lower part of the Carboniferous Slate of Ireland, and the numerous fossils they contained seemed to my eyes to be the same fossils. That some of the fossils are the same is admitted on all sides; and as for the other fossils, they are, at all events, not an Upper Silurian assemblage of fossils, nor belonging to any assemblage which are elsewhere known to be below anything like Old Red Sandstone.

The non-fossiliferous grey slates which lie above the Lynton beds, striking out in one direction on the coast about Ilfracombe and Mortehoe, and in the other running through the country to Simonsbath and Exton, are also precisely like the higher non-fossiliferous portion of the Carboniferous Slate of the county of Cork.

We can in Ireland penetrate down into the purple and green slates and sandstones of the Old Red Sandstone to a depth of 10,000 or 12,000 feet, in numerous glens and valleys in Cork and Kerry; but we never meet below the highest red beds any such groups of grey slate as those of Ilfracombe or Lynton; nor do we find any beds containing marine fossils at all. I believe, then, that the grey slates of Lynton and Ilfracombe are really part of the Carboniferous Slate of Ireland, and, like it, lie wholly above the Old Red Sandstone; and as the red beds which range across North Devon, from Morte Bay to Haddon Down, are exactly the same as the Irish Old Red Sandstone, I believe them to be brought up by a great fault running along the line before mentioned.

If this interpretation be the correct one, and even in Devon itself there is no conclusive evidence against it, it will follow that the subdivision of the rocks into the Upper, Middle, and Lower Devonian, which seemed inevitable as long as the central band of Old Red Sandstone was believed really to lie in the middle of the series, becomes unnecessary.

The rocks of the north coast, the Lynton beds, and the Ilfracombe beds, will thus be placed on the same general horizon as those of Baggy Point and Barnstaple; and the classification of the rocks of Devonshire will assume the same simple type as those of Cork, viz.,

3. Coal measures;
2. Carboniferous Slate, or Devonian beds;
1. Old Red Sandstone.

We know that the Carboniferous Slate of Ireland—a name first proposed by Sir R. Griffith—is a very variable formation; and that, in

tracing it from the shores of Cork Harbour to those of Bantry Bay, it acquires so great a bulk of hard quartzose grits below (called by us Coomhola grits), with so many more and thicker calcareous bands above, that it would be easy to make mistakes in its classification, if we were not able to trace a definite boundary below it by following the red and green slates and grits of the Old Red Sandstone continuously across the country.

In Devonshire it seems to become still more variable, or at least variable in another direction, by taking in great banks of limestone. These are most conspicuous in South Devon; but they show themselves about Combe Martin, in North Devon, while in the intermediate Barnstaple country they are as insignificant as they are near Bandon and Kinsale.

Where the sandstones prevail we get occasionally a peculiar set of fossils, which do not occur elsewhere (several species of Cucullæa, &c.); where the limestones become thick and important, other genera make their appearance (the Stringocephalus, for instance). Even in the slates themselves there is a good deal of difference in the assemblages of fossils that occur in different localities. This is the case in Cork and Kerry; it is therefore not surprising that it should also be the case when we compare the fossils of Devon with those of Ireland, or those of different Devonian localities with each other.

There are, however, certain species which I believe prevail throughout the slates, whether they contain inlying bands of limestone, and peculiar sandstones, or not. These species are the most common and abundant species everywhere; and it is a fact of no little significance that most, if not all, of these species occur also in the Carboniferous Limestone.

I have previously expressed the belief that the Irish Carboniferous Slate must be taken to be contemporaneous geologically with the Carboniferous Limestone. I now believe that the same classification will have to be extended to the Devonian beds when the Old Red Sandstone is detached from them. The hypothesis I propose will effect that for North Devon; while for South Devon, although I have little personal acquaintance with the district, I have, from the perusal of the published descriptions, a confident expectation that it will likewise be found easy to detach a set of non-fossiliferous beds, probably bright red and variegated slates and sandstones, to form an Old Red Sandstone base, the beds above them being a peculiar form assumed by the Carboniferous Slate.

In my former paper I alluded to the apparent possibility of tracing a genuine Old Red Sandstone in the Rhine country between the Upper Silurian beds and the Devonian beds, as proposed by the late Mr. Daniel Sharpe, in his paper in the "Quart. Jour. Geol. Soc. Lond.," vol. ix., p. 23, 1853; but on that point I have no new information to add.

XIX.—Crumpled Granite Beds in the County of Donegal. By William Harte, C. E.

[Read March 8, 1865.]

The Granite of Donegal has been well described as being decidedly gneissose in its character ("Rep. Com. B. A.," 1863, p. 51), and the evidences of this are somewhat varied.

In the Gweebarra Valley, for instance, the granite rocks are very massive, and present a little of the appearance of ordinary gneiss; for they are traversed by bands of black mica (or more micaceous granite than the rest), which give at first an appearance of stratification, which, however, imparts little or no schistose structure to the rock.

Again, we find, inclosed in the granite patches of schists at different places, and into which the granite often seems to pass.

To a third, but distinct class of structure, I have now to direct your attention, which seems to me to have an important bearing upon the question as to the origin of granite, at least of that of Donegal.

We find sometimes, alongside the amorphous and highly crystalline granite, thin slabs of the same texture, and, though the structure is gneissose-looking, quite devoid of lamination.

Nowhere is this more observable than near Dungloe, and at about half a mile from that village, on the road to Maghery, the granite, which lies between the road and the shore, is thinly stratified vertically; and, common as is the contortion, or crumpling, in the case of the gneiss imbedded in the granite, in no instance until here have I met with a similar phenomenon as regards the so-called granite proper.

Those beds vary from one inch upwards in thickness, and may be traced for a considerable width and distance along the shore.

At the point I have described they are intersected by a line of crumpling, nearly at right angles to the beds, which bear 15° E. of N. (Mag.); and, so far as texture goes, there is nothing to indicate whether this plane is that of original bedding (lamination), or not—for the whole is essentially granite in its texture—but its coincidence with that of the ordinary strike of the beds of the primary rocks marks it as such.

These beds "thin out" in a remarkable manner, and in many respects in the same manner as in the ordinary metamorphic and sedimentary rocks.

I lay before you specimens of those crumpled beds, where they "thin out," with "slickenside" surfaces; and also a specimen of the straight beds, showing how the rock is traversed by so many joints, that any attempt to quarry it reduces it nearly to the state of road metal.

This "joint" structure of the Donegal granite has been described by the Rev. Professor Haughton in his "Experimental Researches on the Granite of Ireland," in vol. xviii., p. 403, of the "Journal of the Geological Society of London," where he calls these planes of bedding "cleavage planes," and the intersecting ones "joint planes."

I find the bearings of them to be as follows:—

Cleavage, ...	15° E. of N. Mag.
Joints, ...	85° E. of N. ,,
Ditto, ...	55° E. of S. ,,

Here I may observe, that in the case of this granite much care is required in observation, as these "joint planes" are sometimes so finely developed, that they are scarcely to be distinguished from those of "cleavage," giving, as it were, planes of false stratification; but in these contorted portions of this granite the regularity of the joints is lost, and they are completely confused.

Here, then, we have the same features of plasticity, &c., characterizing the highly crystalline granite that we find in the acknowledged metamorphic rocks, but when the metamorphic action was more powerful, and such as was sufficient to destroy the ordinary appearance of lamination, if it existed; and, as I am not aware of any similar case having been observed before, it struck me as being worth placing upon record.

XX.—Notes on Part of the Leinster Coal Field, with a Record of some Fossils found therein. By William Bookey Brownrigg.

[Read June 14, 1865.]

The following notes relate to the Jarrow colliery, situated under the townland of Cloneen, otherwise Bawn-Jarrow, in the county of Kilkenny. Before proceeding further, I would wish to acknowledge the obligations which I am under to Mr. S. Bradley, the owner of the mines; and to Mr. K. Dobbs and his son, of Coolbawn. It is owing to their courtesy and love of science that I have the honour to lay before the Society, this evening, a collection of fossils; which I believe will be regarded as one of the most remarkable series of specimens which have ever been obtained at one time.

The date of the first boring of the Jarrow mine, in which I discovered these fossils, was 1812. It was first worked successfully in 1827, and continued open till 1832, after which date it was not worked till 1853, when it came into the possession of Mr. Bradley, the present owner.

So far as I have been able to learn, no fossils, of any note, have ever been found in this or any of the adjoining mines previous to those which I have lately discovered. The principal seam in it is known as the "four-feet coal," and it is the hardest and least stratified in the district.

The part of this mine which is worked presents the following section, reading it from the ceiling downwards to the coal-seat:—

The roof is formed of five feet of "clay slate," immediately under which there occurs a seam of "inferior coal," about three inches in thickness. Next beneath this lies the best seam of coal, known as the

"stone coal," which is about three feet in thickness, and rests on a worse description of "foliated coal," about one foot thick. Underlying all these there exists a layer of slaty coal, nine inches in thickness, and known to miners as the "wire sole." Immediately under the wire sole there is a four-inch coal, resting upon what the miners call a "white slate," which latter is two feet in thickness, and is superposed to a bed of "culmy coal," six inches in thickness, resting directly upon the coal seat.

Nearly all the fossil genera of which I have obtained specimens in this mine are confined each of them principally to a particular stratum. I may also mention that the four-feet seam is not to be met with in any of the adjoining mines; which I think may probably be explained by the supposition that it forms part of what was once the uppermost stratum, or innermost saucer-like bed of the basin in which these deposits were formed.

I have now the honour to lay before you specimens of the fossils which I have obtained. I believe that I shall be found to be correct, when I express it as my opinion that I lay before the Society this evening, amongst other specimens, at least six, if not seven, perfectly new genera of reptiles.

I have brought these remarkable fossils before you perhaps somewhat prematurely, and while the specimens which I have obtained are more or less imperfect, principally with the view of securing the priority to the discovery, and the priority of publishing their notice to our "Journal."

I do not attempt to enter this evening into what would necessarily be an imperfect description of them, in the present stage of the inquiry: as I do not believe that it would be for the interest of science that I should do so until I shall have obtained more perfect specimens. However, I hope to be in a position to describe them at no distant day; and I desire to take this opportunity of thanking our Council for most liberally promising to illustrate such description with four Plates, in our "Journal."[1] There is one fossil in particular which I would wish more particularly to notice, on account of its very remarkable hour-glass shaped caudal vertebræ and processes, and which I propose to call "Wandesfordii," after Mr. Wandesforde, the lord of the soil.

In conclusion, I feel happy in having been so fortunate as to rescue even those few specimens now before you from the work of geological destruction which is daily proceeding in all mines and quarries throughout the world. As each part of any mine is abandoned, being commercially exhausted—as each pillar is fired, each portion of the roof allowed to fall in—there is lost for ever to Palæontology an accumulation of records, whose destruction is hardly less sad to science to contemplate than the burning of the Alexandrian Library of old was to knowledge. It therefore the more behoves all "brethren of the hammer" to be constantly up and doing. This work of destruction is taking place in every part of the world every day, and therefore they should be on the look out every hour, in whatever part of it they may be living.

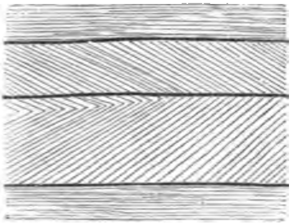


Fig. 1.

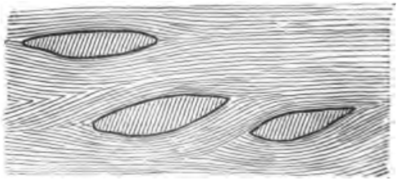


Fig. 2.

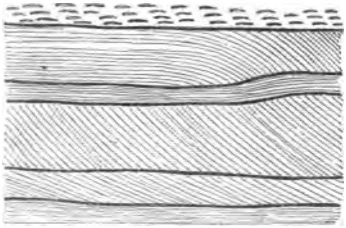


Fig. 3.

Fig. 4.

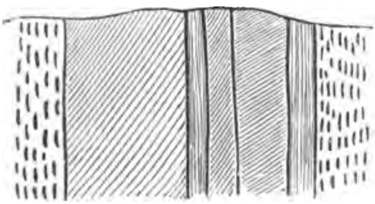


Fig. 5.

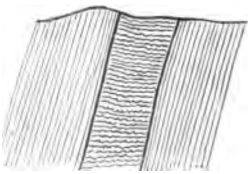
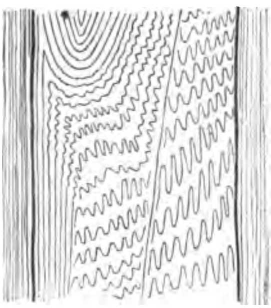


Fig. 6.



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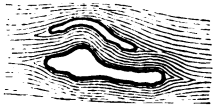

Fig. 8.

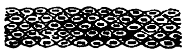

Fig. 9.

TO ILLUSTRATE MR. KINAHAN'S PAPER ON THE FOLIATION IN THE GNEISS AND SCHIST OF YAR-CONNAUGHT.

Who can tell what vexed problems of the geologist may have their solutions lost for ever to science by each day's recurring operations in mine or quarry?

XXI.—Notes on the Foliation in the Gneiss and Schist of Yar-Connaught. By G. Henry Kinahan, Senior Geologist of the Geological Survey of Ireland.

[Read January 10, 1866.]

The foliation in the metamorphic rocks of Yar-Connaught seems generally to follow some variety of lamination, and rarely the cleavage planes; I shall, therefore, first copy from my note book the places in which it may follow the cleavage.

A little north of Lough Seecon (*Galway*, $\frac{54}{4}$),* "the foliation is slightly oblique to the bedding, and seems to follow the cleavage planes."

In the stream, a few yards west of Knockbane gate (*Galway*, $\frac{68}{3}$), "the foliation in a bed of schist is slightly oblique to the bedding, and seems to follow the cleavage planes."

Keerauntoole (*Galway*, $\frac{53}{2}$), about half a mile due north of Lough Adrehid, "the foliation generally follows the lamination; but in one bed of schist it seems to follow the cleavage planes."

Curraduff West (*Galway*, $\frac{39}{4}$), "in the stream south of Captain Tracy's Lodge, in a bed about five feet thick, there is a foliation oblique to the bedding; and, as the rock is more a schist than a gneiss, perhaps it may be the cleavage planes that the foliation follows."

The foregoing are the only instances which I find in my note book; and though in each of these places I believe that the foliation coincides with the cleavage, yet in no place would I be quite certain, as it might be the oblique lamination that it followed.

Oblique lamination is usually common in grits and sandstones, and in the gneiss of Yar-Connaught oblique foliation is common. I shall mention a few instances.

In the townland of Derryeighter (*Galway*, $\frac{53}{4}$), a little south of Knockwaumnamoe, the foliation in the gneiss is oblique; a sketch of this will be found at Plate VI., Fig. 1. In the townland of Doon (*Galway*, $\frac{67}{4}$) part of six beds were sketched, in three of which the foliation was oblique (see Fig. 3). The highest bed in this sketch is meant to represent a Porphyritic Granite. Fig. 4 was taken near this place; it shows doubly oblique foliation in one bed.

Fig. 5 is a diagrammatic section of a cliff a little east of Letter Lodge (*Galway*, $\frac{67}{4}$); the general rock thereabouts is a foliated Granitic Porphyry; but in this place there is a vein of green gneiss, consisting of five beds, the foliation in the first and fourth of these, counting from

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* This refers to the quarters into which each Sheet of the Ordnance Maps is divided by the officers of the Geological Survey.

the right hand (east side), is parallel with the foliation in the granite, while in the other three it is more or less oblique.

I find that I noted, "in the gneiss the foliation generally followed either the lamination or oblique lamination;" but to this there are exceptions. At the south-east corner of Curraghduff East (*Galway*, $\frac{40}{3}$) a very quartzose gneiss was observed, full of small almond-shaped particles of quartz, round which the foliations curled. This I have tried to represent in Fig. No. 9. In some places there is also a nodular foliation in the gneiss; but this is not very common. Good examples of it, however, will be found among the rocks that appear in the neighbourhood of the town of Galway, more especially in the low swampy tract of ground through which the railway runs S. S. W. of Lough Atalia. There the nodules are generally whitish or reddish (*micaceous gneiss*), while the rest of the rocks are blackish or greenish (*hornblendic gneiss*), which gives them a very marked appearance.

In shales there are a variety of structures; a very common occurrence is to find a "curled" or spheroidal structure; numerous sketches of which will be found in the "Memoirs of the Geological Survey," more especially those written by Mr. Du Noyer;* and in the schist we find a spheroidal foliation. Good examples of this were noted in the townlands of Leam West and Bunnakill (*Galway*, $\frac{55}{1}$), a little east and north-east of Lough Aphreaghaun. In that neighbourhood this kind of foliation is extremely well developed, but it will also be seen in other places, having been observed in the hills west of Glan (*Galway*, 39 and 40),‡ on the hills west of Ross Lake more especially about Knockseefin (*Galway*, 67), at Leam (*Galway* 53), which lies west of Oughterard, &c.

Another structure that occurs in shales, and to which I drew the attention of the Society some time since,§ is the crumpled or wavy lamination. This also has its representative among the varieties of foliation; an example, of which Fig. 6 is a sketch, was observed a little north of Lough Seecon (*Galway*, $\frac{54}{4}$), in a thin bed of mica schist, between two beds of gneiss. An excellent illustration of it was seen in the townland of Lettercraff (*Galway* $\frac{54}{1}$). Fig. 7 is a rude sketch of it; but it only gives a faint idea of what it really is, as the crumpling is so intricate that it would be impossible to copy it, except by a photograph. Another variety of curled foliation is when nodules appear in the mass round which the foliation curls. This, as before mentioned, is found in the gneiss, as well as the schist. Fig. 2 represents an example which was observed in the townland of Killaguile (*Galway*, $\frac{67}{2}$). This is a most instructive case; for, besides the foliation of the schist curling round the nodules of gneiss, the latter are found to be obliquely foliated. A

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* "Memoirs of the Geological Survey of Ireland." Ex. Sheet 137, p. 23; Ex., 162, p. 16; Ex., 175, p. 27, &c.

† It also occurs in the gneiss, but not so frequently.

‡ This name is not usually inserted in the Maps; but the tract of low country west of Lough Corrib and north-west of Oughterard is always called by that name.

§ See "Dublin Quarterly Journal of Science," vol. iv., p. 112.

very common case is, when the nodules are of quartz; Fig. 8 is a sketch of two quartz nodules in curled foliation that were remarked in the townland of Gorteenwalla (*Galway*, $\frac{40}{5}$). The foregoing are cases in which the foliation follows peculiar varieties of lamination. The lamination in rocks is usually parallel to the planes of stratification, so in Yar-Connaught the foliation is generally parallel to the same; it is, therefore, unnecessary for examples of this kind to specify any particular locality.

I have now mentioned six varieties of foliation, one of which may follow the cleavage planes, while the five others follow the lamination; the parallel foliation being caused by the parallel lamination; the oblique, by the oblique lamination; the spheroidal, by the spheroidal lamination; the crumpled, or wavy, by the crumpled lamination; and the curled, by the lamination that is curled round the nodules. These, at least in this district, seem to be the only structures that cause it; for, though it is easy to tell a rock that was originally jointed by the "jumped" appearance of the foliation, yet, if the latter is examined, it will be found to follow one of the six structures just now enumerated.

I would venture to suggest that any one interested in foliation could learn much by carefully examining Yar-Connaught; as, besides the foliation that I have just mentioned in the gneiss and schist, he would find a curious structure, like foliation, in the intrusive granite, and peculiar foliations in the metamorphic trap masses and dykes, and in the metamorphic conglomerates and limestones, and also many interesting cases where the rock masses had originally been cut up by small faults, or where pieces of hard beds had been squeezed into the adjoining soft ones.*

None of these latter have I entered into, as it would make my paper too long, besides that all of them, excepting the limestone, are in a manner foreign to my subject.†

XXII.—On a Trap Rock at Bray Head, County of Wicklow. By W. H. Stacpoole Westropp, M. R. I. A.

[Read April 12, 1865.]

Bray Head is composed of Cambrian grits, slates, and quartz-rocks, which have a general dip of from 40° to 90° towards N. 12° W.

On the top of the hill several masses of amorphous quartz-rock occur, of which only two come down to the sea shore—the northern or

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* Examples of these squeezed beds in unaltered rocks will be found in the "Memoirs of the Geological Survey of Ireland," Ex. of Sheet 128, p. 18, and Ex. of Sheets 115 and 116, p. 25.

† I have not included the limestone in these notes, although it seems to follow similar rules to those of the gneiss and schist, as there is something about it which as yet I do not quite understand.

Brandy Hole one and the great southern or Windgates quartz-rock, which form such prominent features in the scenery of the Head, their yellow colour and rugged form contrasting finely with the sombre tints and smoother outline of the grits and slates.

Some time ago, Professors Harkness and King discovered a bed of greenstone about one hundred yards south of the Windgates quartz-rock, by the side of an old road, running a little above the present walk, which skirts the eastern side of the hill;* these gentlemen told Mr. Jukes of its occurrence there; and during Easter week last year (1864), Mr. Jukes showed it to me when he was giving a field lecture to his geological class; he said he had traced it up the hill, but that no one had tried to find its extension down to the sea shore.

I spent some days last summer in examining it, and I hope that a brief description of the facts which were observed will have sufficient interest to excuse my bringing them under the notice of the Royal Geological Society of Ireland.

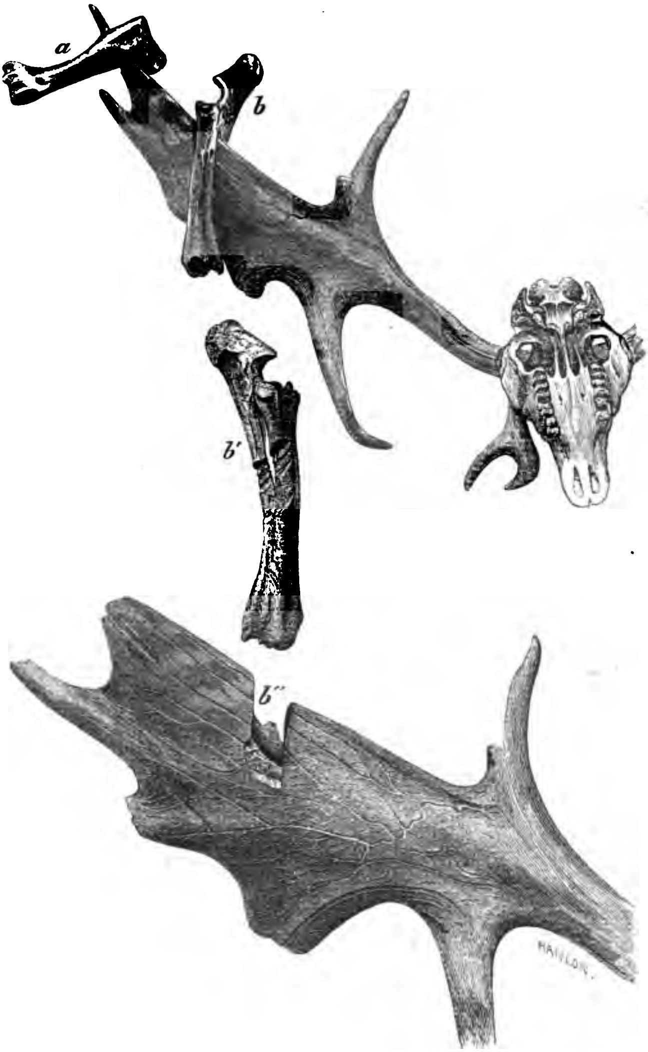
From the place where the trap can be first seen towards the top of the hill, down to the spot where Professors Harkness and King noticed it by the old roadside, it appears to occur in one bed about five feet thick, regularly interstratified with the grits and slates. In the cliff between the walk and the railway it begins to show a tendency to split up; for a second bed, only an inch or two thick, appears, which runs parallel to the main bed, and is separated from it by grits, &c.

The trap disappears under the railway embankment, and would not be again seen but for a fault having an upthrow to N. N. W. of about 150 feet; this brings up the trap about sixty yards to the north, where it may be seen on both sides of the railway, near the south entrance to the tunnel, whence it can be traced down to the sea shore. Below the railway it becomes split up into several beds; and on the sea shore I counted as many as seven, varying in thickness from two inches to one foot; there are also some curious fine veins 0·25 to 0·5 of an inch thick.

The rock is greenstone, having different textures in different parts; up the hill, where it occurs in one bed, it is a hard, finely crystalline rock, of a dark greyish green colour, and very durable, for it is scarcely at all affected by weathering; but where it becomes split up into a number of beds, it is a rotten brownish-green rock, with numerous black specks of a mineral, which probably is hornblende; some of these thin beds have quite the look of an ash.

The trap is so regularly interstratified with the sedimentary rocks, that at first sight it might be supposed to be contemporaneous; however, I believe it to be intrusive; for the fine veins, before alluded to, may be seen entering into the adjacent beds of slate—some dying

* Fossil collectors may be glad to know that between the quartz-rock and the trap there is a bed of fine purple slate, full of *Oldhamia radiata;* I also detected in it the rarer form *O. antiqua*, and marks like those which have received the name of *Arenicolites*.



a Humerus *in situ.*
b Radius and Ulna *in situ.*
b' Radius and Ulna turned, so as to show indentation.
b'' Cut in Antler, into which *b'* fitted.

TO ILLUSTRATE DR. CARTE'S PAPER ON INDENTED BONES OF THE CERVUS MEGACEROS.

away, while others cut across the laminæ of the slate in a manner that I cannot think an ash would behave; nevertheless, any one examining a hand specimen of one of these veins would be inclined to call it an ash.

I think it not improbable that the more crystalline part, up the hill, may be nearer to the focus from which the flow originally proceeded than are the thin beds on the sea shore.

In conclusion, I beg to observe that, while there is such a profusion of igneous rocks associated with the Lower Silurian deposits of Wicklow, it is rather remarkable that one small greenstone dyke at Greystones, and the trap I have just described, are the only ones which have yet been found in the Cambrian rocks of that county.*

XXIII.—On some Indented Bones of the Cervus Megaceros, found near Lough Gur, County of Limerick. By A. Carte, M. D., F. L. S.

[Read March 8, 1866.]

It will be in the recollection of most of the Fellows that Mr. Jukes on a former occasion (December 9, 1863) laid before the Society a paper on a subject similar to that which I now have the honour to bring under your notice. The bones exhibited by Mr. Jukes were discovered underneath a bog, near the village of Legan, in the county of Longford; and in his paper he gave an accurate geological description of the locality where those remains were found. It will be remembered that in this case the bones were not seen in actual contact with each other *in situ* by Mr. Foot; and this part of the evidence rests on the testimony of Mr. Shaw, the owner of the ground.

My attention having been called to this interesting subject by Mr. Jukes' communication, in the course of the autumn of last year I had an opportunity of inquiring of Mr. William Hinchy, of Limerick—a man who has had great experience in finding and collecting the remains not only of the Megaceros, but of other sub-fossil animals, and who happened to be at that time in town, whether he had ever noticed such marks as formed the subject of discussion at the Society. He at once informed me that he had frequently seen such marks, but had never paid any special attention to them. I then requested him to send me up any marked bones which he might be fortunate enough to discover. Ac-

* However, in the county of Dublin, at the Hill of Howth, there are numerous trap rocks. I believe them to be, without exception, intrusive. From these data we may safely infer that during the period when the sand and mud were being deposited, which now form the Cambrian rocks of the east of Ireland, there was no volcanic action going on, and that many, if not all, of these trap dykes were intruded during the succeeding geological period; for in the Lower Silurian rocks of the county of Dublin, at Portrane, Lambay, &c., and in rocks of a similar age throughout the county of Wicklow, *contemporaneous* traps and ashes are extremely abundant.

cordingly, I have received from him the specimens which are now laid on the table, and which consist of the following—viz., right humerus, right radius and ulna, right cannon or metatarsal bone, left radius and ulna, ditto tibia, ditto cannon or metatarsal, ditto calcis, and the palm of the left horn, indented or marked in two places.

I have received some information from my friend Dr. Samuel Bennett, of Bruff, who was present on the day on which the marked bones were found. He says, in a letter, dated the 28th of February, 1865:—"The place where the large heads have been found was at one time, I presume, a forest, as within the memory of the oldest inhabitants large ash trees have been cut down on the lands, and no doubt bog deal was found in the cutting of the turf. I am told that the surface of this place was covered with bog to a depth of some forty or fifty feet; and within the last forty years a depth of ten or twelve feet of bog was cut away, leaving the surface now on a level with the surrounding land. Strange to say, the deers' horns are still to be found from four to five feet or more below the present level. In some places the springs are so pressing on the workmen, that they are obliged to give up the work. At one side of this bog—no longer to be called so, as the place is covered with coarse grass in summer, and with water in winter—there are three hills, not very high—one called Knock Bullog, the second called Knock Strahane, and the third called Moohane."

The piece of ground where the bones were found is situated, as I learn from Dr. Bennett, on the left bank of the River Camoge, about one mile from Lough Gur, and is close to the ruined castle near Kilcullane House, townland of Kilcullane, parish of Herbertstown. It is about three-quarters of a mile long, and about three hundred yards wide. I learn from Mr. Hinchy that between August 15th and October 10th, 1864, twenty heads were found in this place; and about twenty-five years ago thirty or forty more were found in the same locality by those who were employed by Mr. John Abel, of Limerick, to search for them. The heads are discovered by probing the ground with a long iron rod, in a manner similar to that by which bogwood is found. Hinchy has found three in one hole from twenty to twenty-five feet in diameter, and I have further received from him some additional information relating to the position of the bones. He says that the marl in the district is very firm, cutting like cheese, and of a lightish colour. The head was found some four or five feet under the surface, and three feet in the marl, very firmly fixed. One foot of the top is composed of earthy stuff, with turf mould, on which coarse grass grows; the other four feet are rich marl; and underneath is a "bluish tough stuff," out of which you could scarcely pull the horns without damaging them. The head was found 100 feet from the foot of Knock Bullog, a hill about 250 feet high above the level of the bog. The place was quite dry and firm last summer; and Hinchy says that, though covered with water in winter, it dries and cracks very much by shrinkage in summer.

The first bone I shall call your attention to is the left metatarsal, or cannon bone, on the upper and outer surface of which there is a small,

oval, highly polished depression, caused by the loss of the osseous tissue. The long axis of this, which is about one inch in length, corresponds to the long axis of the bone; its short axis, which is about $\frac{9}{16}$ of an inch, corresponds to its transverse diameter. The surface of this oval depression is concave in its long, and convex in its short axis. On the inner and lower fourth of the left tibia there is a similar oval highly polished mark or depression, with loss of bony substance; its long axis is inclined at an angle of about 45° to that of the shaft of the bone, its surface being convex in this direction. The short axis of this depression is also inclined, at an angle of about 45°, to the long axis of the bone, and its surface is concave. When these two depressions are brought into contact, they mutually fit into each other, the concave surface of one corresponding to the convex surface of the other. These bones, it would appear, lay across each other at an angle of about 45°. On the inner and upper third of the left radius there is a long oval highly polished mark with loss of osseous substance; it is two inches long by $\frac{9}{16}$ of an inch wide, its long axis running at an angle of about 30° to the long axis of the bone, and on the inner and upper third of the right metatarsal bone there is a similar highly polished depression, which fits accurately the depression on the left radius. On the upper, outer, and posterior aspect of the same metatarsal bone, the ridge which forms the external boundary of the groove for the tendons is worn into a concavity from above downwards for the distance of about $2\frac{1}{4}$ inches, and is highly polished; this surface fits accurately into a cut or groove which is situated on the inner surface of the left os calcis, the cut being about $2\frac{1}{4}$ inches long by $\frac{7}{16}$ of an inch wide, being convex in its long and concave in its short diameter.

The most remarkable of all, and that which throws the greatest light, if it does not indeed solve this interesting question, is the indentation, or cut, to speak more truly, on the outer and upper surface of the right radius and ulna (Pl. VII., Fig. 2); the former is deeply worn away, nearly exposing its medullary canal; it is scored as if by the action of a rope playing over and fretting it; the ulna is in a similar state. These surfaces are not, like the others, polished, but present a rather roughened appearance, as if they had been in contact with a substance composed of different densities. These two bones were discovered *in situ*, imbedded in a deep cut in the posterior edge of the palm of the left antler, into which they fit. (Pl. VII., Fig. 1). The right humerus on its inner, upper, and posterior aspect, just beneath the head of the bone, is deeply cut into, so deep that the medullary canal is exposed; this cut, like that on the radius and ulna, is not polished, but rough, in consequence of its cancelated structure being exposed. This bone, when *in situ*, was found in contact with the posterior and most distant tine of the left antler, a portion of which, about six inches long, it had severed from its connexion with the palm.

During the discussion which followed Mr. Jukes' paper I ventured to express the opinion that the phenomena were produced by the action of pressure and friction, and not by the former alone; and I apprehend that the explanation I then gave is fully borne out by the specimens now

before you. The roughened state of the radius and ulna, before alluded to, was evidently produced by the unequal density of the cancelated structure of the horn acting on the surface of these bones through the medium of the fine particles of sand that enter into the composition of the marly bed in which they lay—the opposed surfaces of the bones, with the aid of the interposed sand, grinding each other away by the perhaps slow but long-continued motion of the surrounding boggy ground, which latter during the summer months contracts and sinks considerably, from the drying up of the soil producing a downward motion of the mass, whilst its upward motion is produced by the expansive force of cold and moisture during the winter season. This simple mechanical process of an alternate up and down motion will, I am inclined to think, fully explain the phenomena.

XXIV.—On the Occurrence of Kjökkenmöddings in the County of Donegal. By William Harte, Esq., C. E., County Surveyor of Donegal.

[Read February 7, 1866.]

The great interest which attaches to the subject of the shell mounds of Denmark, Scotland, &c., must make the record of the occurrence of similar formations in Ireland a matter of some importance, and it scarcely needs apology from me for bringing it under the notice of the Royal Geological Society of Ireland—important even if it should only direct the attention of those to the subject who have an opportunity of observing perhaps still more interesting cases in other localities, but which have hitherto escaped observation; for I believe that these shell mounds have rarely, if ever, been met with in this country before. It would be out of place for me, before this Society, to enter into an explanation as to what Kjökkenmöddings are; but, as this paper may answer to a certain extent as an advertisement to some who, though they may meet with such, may not be so well informed as geologists are, I may say something by way of general description, in the hope that before, as I have reason to fear is too often done, these valuable records of the past are destroyed by manuring land with them, we may be afforded an opportunity at least of examining, if not of preserving them. Briefly, then, I may mention that along the coast of Denmark particularly, and later still in Scotland, have been found large heaps of shells, which have been proved beyond all doubt to be the refuse heaps of the earliest human inhabitants of those countries, and among them the remains of animals and plants, the study of which has thrown some light on the history of the Fauna and Flora of those times, as well as upon that of the antiquity of man himself, for among them his works, implements, &c., have been found also; and here we are taken back to that neutral ground where the geologist and the archæologist meet.

I now proceed to describe the instances I have to bring before you. While investigating the Drift in the neighbourhood of the Island of

Inch, which forms part of the eastern side of Lough Swilly, in the barony of West Innishowen, my attention was attracted by a bed, or rather the remains of a bed, of oyster and other shells, lying just upon the slope of the "boulder clay," through which the Derry and Buncrana Railway is cut, immediately at the Inch-road Station, and a moment's examination sufficed to convince me that I had come upon a true Kjökkenmödding. While ascertaining the height of the bed above high-water mark, an intelligent countryman, who had joined me, undertook to enlighten my ignorance, and remarked—"Sure the sea was never up there at all, but in ould times the people used to gather here to eat oysters," and, he added, confidentially, and with a knowing smile (evidently anxious that I should have a good opinion of the wisdom of his ancestors in the face of so much cold oysters) "to drink whishkey." I confess I was at first staggered by this; for, strange to say, at this day a custom prevails in the Bay of Donegal, the Carboniferous rocks of which are covered by delicious mussels (*Mytilus edulis*), where the mountaineers from the Barnesmore Mountains, with their families, about Easter, come down in their carts, turn their horses adrift, and squat for days (and nights, too), and roast and feed upon these shell-fish. It is a sort of holiday proceeding, and if any one wants to see very recent Kjökkenmöddings, he has only to visit St. Ernan's shore, near Donegal, and he will find them there—shells, fireplaces, whiskey, and all! No doubt, it was this association of ideas that made my informant come to the conclusion he did. Immediately I set to hunt for flint implements, but none were to be got. I heard, however, that there was a similar bed about a mile away, and I started for it. Here I was more successful, and found several.

I call the first bed No. 1, this other No. 3; and on my way back I found the remains of a third lying between the two—this I call No. 2. Those three shell mounds I have marked upon the sheet No. 11 of that beautiful production of the Ordnance Department, the One-inch Map of Ireland; and you will perceive that the Island of Inch stands in the mouth, as it were, of the cross valley which runs from Lough Foyle to Lough Swilly; thus forming two channels—the one to the south being called the "Farland," and that to the north the "Fahan" Channel. Up both these channels the sea flowed round the island, and some distance inland, until Mr. M'Cormick, the late Member for Derry, made an embankment across each, thus reclaiming large tracts over which the sea flowed to the N. E. and S. E. of Inch. No. 1 is at the end of the embankment, near the railway station; No. 2 is at the opposite end, on Inch Island; No. 3 is at the north end (on Inch) of the Farland embankment. I have no doubt but there must have been a corresponding fishing station at the south end of this embankment; but, if so, it has gone bodily to make the railway and the embankment.

It will be seen, on reference to the Ordnance Sheet, that there is another "reclamation" of an arm of this estuary at a place south of the Farland, called "Blanket Nook;" and, judging by analogy that there should be another shell mound there, I visited it. I had no difficulty

in finding, close to the embankment, the remains of a far larger bed than any of the others. It has, however, been greatly disturbed, but the situation and character of the shells were the same (the oysters, however, were not so large) as the others. Still, in the short visit which I was able to pay it, I myself found no flint flakes, or other implements. I believe a good deal of the shells have been burned for lime. The whole bed has been dug over, and the sea seems to have encroached upon it, as it is much more exposed than the others. I have marked it No. 4, and have since received some flint flakes and split bones, which were found there by my assistant. Nos. 1, 2, and 3, are all situated close to the shore, and at the same level, twelve to fourteen feet from high water, a little sheltered from the west, and high enough, no more, to be out of the wash of the waves. The greater part of No. 1 has been levelled down, and removed, and but little of it remains. It is from eighteen inches to two feet thick, evidently on the edge of the original mound. No. 2 is nearly all away, removed for filling or manure. No. 3 is likewise much destroyed, but what is left of it is in better preservation than the others. It is from two to three feet thick, and a great deal of what has been removed has been spread over the land immediately adjoining it.* I exhibit several flint flakes, and one axe, with the number of the mound on each from which I obtained them.

The following description, except where special mention is made, applies equally to 1 and 2—these mounds show good sections, being cut right through. The shells are a good deal compressed, free (except where the surface has been dug a little into the shell bed) from any admixture of sand, gravel, or loam. The shells are for the greater part those of full grown Mollusca, the others being exceptions. Scarcely any of the Turritellæ or small shells are to be met with, which are so characteristic of raised beaches. The different kinds are more or less grouped together, too; they are not rolled, and have evidently never been disturbed since they were first placed there. In No. 3 stones were found bearing the marks of fire, and one lump of cemented oyster shells, too hard to break except with a crowbar, which had been, I think, so made by the action of fire and pressure, for in it were embedded ashes or charcoal; I exhibit specimens of both. No pottery has been found, and only one entire bone—a vertebra—which my friend Dr. Carte has been so kind as to identify for me as probably that of a red deer (*Cervus elaphus*), and I am also indebted to him for the revision of the following list of the species found:—

INVERTEBRATA.

MOLLUSCA.

GASTEROPODA.—*Buccinum undatum*, common; *Litorina litorea*, common; *Litorina litoralis*, very plenty; *Trochus magus*, very plenty, and

* It is hard to say what the length of those heaps was; No. 1 appears to have been about eighty yards long, No. 4 much longer.

all large; *Nassa reticulata*, uncommon; *Natica*, uncommon; *Purpura lapillus*, uncommon; *Patella vulgata*, not very common.

CONCHIFERA.—*Ostrea edulis*, very common, and forms the principal part; *Pecten maximus*, uncommon; *Pecten varius*, rather common; *Mactra truncata; Mytilus edulis*, not common; *Cardium edule*, not common; *Tapes decussata*, common; *Tapes pullastra*, common; *Mactra elliptica*, rare.

Those Molluscs live on this shore now.

VERTEBRATA.

AVES.

A wing bone of a goose and some fragments of ribs.

MAMMALIA.

One lumbar vertebra of a ruminant, probably *Cervus elaphus*, and a number of bones of ruminants, split for the extraction of the marrow.

The oysters, the shells of which are before you, are far larger than the oysters of the same locality at present. Inch was celebrated for its oysters a few years ago; that is, it produced quantities of a very small oyster, which sold at about fivepence a hundred—the produce of a hundred not at all compensating the trouble of opening them. They are the dwindled descendants of the fossils before you; and probably this degeneracy is due to the greater quantity of fresh water coming down in times of floods into the Lough, owing to drainage, &c. At present the almost only use made of these oysters is that they are packed up in barrels as young oysters, and, in the teeth of all "artificial selection," exported to England as seed oysters to stock new beds! It is scarcely necessary for me to point your attention to the implements before you, but you will see that they are highly characteristic of the Danish Kjökkenmöddings. They are rude in the extreme, and belong to the class of Stone implements called "flint flakes"—those of the earliest Stone age, and without a trace of that polish or beautiful finish which I have seen in the private collections of more than one gentleman in this country, illustrating the later Stone period. The stone axe alone, from No. 3, made of a brownish quartz, is perhaps some little exception. Some few of the stones are doubtful-looking, but they seem to have been used for some purpose.

It has been remarked that in loughs those shell mounds are better protected that on the sea coast. Here is an instance of it, and I hope one that will induce others to look out for them; and, as there ought to be many more in Lough Swilly, and I have no doubt in Lough Foyle too, I shall be most happy to explore them for any one who will kindly direct my attention to what appears to be such. These shell mounds are interesting from another point of view, too. There is an old tradition that the country in which they occur was an island. It must have been, however, about the same time, three islands—viz.,

Inch, then the country north of that as far as the valley from Malin to Culdaff; and the third, from that valley to the sea. Was it so within the human period? Certainly not at the time of these shell mounds. Those who made them carried their food sufficiently high up to get out of the reach of the waves; so that the land has not been upraised since that, or these mounds would be higher up; neither has it been depressed, for, as I have said, there is not the slightest trace, but quite the contrary, of the sea ever having reached them, which it would do (at least its waves would) if they were lowered ever so little. General Colby, in his Ordnance Memoirs of Derry, explains the etymology of Innishowen as being Innis Eogan, or the "Island of Eogan," as it is nearly insulated by the two arms of the sea, called Lough Foyle and Lough Swilly. This scarcely goes far enough. An elevation of the sea, little more (about twenty feet) than would submerge these Kjökkenmöddings, would render it a complete island, or, as I said, three islands; for it would flow up the valley to Lough Foyle, along the course of the Derry and Lough Swilly Railway, and, what is more important, it would also fulfil the other tradition which also exists of the passage of the sea from Malin to Culdaff through the parallel valley to the north. But I think I can see another solution of the question; for, if a man was an inhabitant of this country when its Drift was formed, then undoubtedly he was a witness of the existence of these islands; but, even if not so, the wild men who made these shell mounds, as they stood there, before the vegetable soil was formed which now covers their work, and the Drift alike, must have observed the fact that the sea had but lately, comparatively, left the valley dry; they had fresh before them the records of the Glacial epoch, which we have but to lift the mere sod which covers the rock even now to see too; and they doubtless named their fishing grounds as islands, one of which, in ages after, became the "Island of Eogan."

Note.—Since writing the foregoing, I have found also two other stations, a little to the west of the old castle upon Inch Island. Here several fine flakes were found, and one good "core," showing that raw material was imported (as Professor Jukes has observed) from Antrim, and manufactured upon the spot. Some other points of interest were observed also, of which I reserve notice for the present.

XXV.—Report of Council.

[Read at the Anniversary Meeting, on Wednesday, February 7, 1866.]

At the close of this, the second year of the existence of the Royal Geological Society of Ireland, the Council have to congratulate the Society on the high and satisfactory position which their body has held during the year which has just passed. The number of Fellows has been slightly increased, though death has been more than ordinarily busy in

our ranks since the last anniversary meeting. We have lost six of our number; and though those who are gone did not belong to the working portion of our body, yet we cannot but miss from our monthly meetings the familiar faces of some of those whose names we find on the melancholy list.

Among those whom we have lost have been two of the most eminent men, in their respective lines, in Europe, of the present day; and it would ill become us to attempt to add aught to the biographical sketches which have already appeared of them. Lord Palmerston, though for twenty-two years a member of the Geological Society of Dublin, never took an active part in its proceedings; but Sir William Hamilton—one of the original founders of the Society, and a member of its first Council—in former years attended its meetings; and our "Journal" is honoured by one communication from his pen, on a subject upon which his experience, as Astronomer Royal, fitted him more especially to give an opinion. The paper was brought forward by Mr. Mallet, during the year of his Presidency, in 1846, and the subject was the "Existence of Secular Variations in Level of the Earth's Crust." Sir W. Hamilton mentioned the fact of his having observed that the stands of certain instruments in the Observatory at Dunsink showed alterations of level corresponding to the differences of the seasons; while alterations, the converse of these, had been noticed at Markree, and elsewhere.

Mr. George M'Dowell had been connected with the Society for fifteen years, and had for two sessions filled the office of Honorary Secretary; known as one of the ablest mathematicians of the University to which he belonged, his long connexion with and experience in mines rendered his opinion on matters therewith connected one universally and deservedly respected. He was the author of one paper, "On the Wolfhill and Modubeagh Colliery," which was read before the Society in 1860, and has been printed in our "Journal."

Dr. Edward Hutton occupied a most distinguished position in his profession, the active duties of which engaged his attention so completely that he was able to devote but little attention to geological pursuits.

In addition, we have to regret the loss of Mr. J. Connolly and of Mr. J. Hancock Haughton; the latter of whom, though he never actively entered into the investigations carried on by our Fellows, yet, at considerable personal inconvenience, attended our meetings regularly.

Two of our Fellows have resigned during the session; and, in addition, the names of three have been removed from the list for nonpayment of their subscriptions.

Thirteen Fellows have been elected during the year; and in addition the Council have recommended two gentlemen for election to the distinction of Honorary Fellowship—viz., M. A. Descloiseaux, the eminent mineralogist; and Captain R. F. Burton, so well known for his geographical explorations, and his discoveries on the continent of

Africa, and elsewhere. This suggestion was at once unanimously adopted.

Since our last anniversary meeting the Diploma of the Society has been lithographed from a design by one of our Fellows, Mr. W. H. Baily, and it has been distributed to all of the Fellows who have paid Life Composition; and also to such of the Annual Fellows as have been connected with our body for ten years.

The accession of dignity to the Society which Her Majesty was pleased to confer upon us has had one very sensible effect—viz., that the number of applications from foreign societies for an exchange of our "Proceedings," has been extensively increased during the past session.

In the course of the year the Catalogue of our Library, which had been set on foot by Messrs. W. B. Brownrigg and W. H. Baily, was completed by your Honorary Secretaries, and printed, and is now on sale to the Fellows, inasmuch as the state of our funds would not allow of its being distributed *gratis*. It is to be hoped that the publication of this Catalogue will have the effect of rendering our Library more available to the Fellows than has hitherto been the case.

The session was opened by a short paper by Mr. Harte, on "Some Crumpled Granite from the County of Donegal." This was followed by a communication from Dr. Carte, relating to some marked antlers of the Megaceros, which led to a most animated discussion. It will be remembered that Mr. Jukes' paper on a similar subject had been received with the greatest interest by the meeting, when it was read on the 9th of December, 1863. The specimens which formed the subject of Dr. Carte's paper differed materially from those which had been already described, both in their nature and in the facts connected with their discovery. The new circumstances with respect to the instance now under consideration are the following:—

1. There is no possible ground of utility to man which could be alleged for the bones having been placed in juxtaposition.

2. There is distinct and positive evidence, from observers who have been in the constant habit of finding Megaceros bones, of the relative position of the bones when found.

The instances of marked bones were very numerous; and the most remarkable of them all—to use Dr. Carte's own words:—"Is the indentation, or cut, to speak more truly, on the outer and upper surface of the right radius and ulna. The former is deeply worn away, nearly exposing its medullary canal; it is scored, as if by the action of a rope playing over and fretting it; the ulna is in a similar condition. These surfaces are not polished, but present rather a roughened appearance, as if they had been in contact with a substance composed of different densities. These two bones were discovered *in situ*, imbedded in a deep cut in the posterior edge of the palm of the left antler, into which they fit. The right humerus on its inner, upper, and posterior aspect, just beneath the head of the bone, is deeply cut into, so deep that the medullary canal is exposed; this cut, like that on the radius and ulna, is not

polished, but rough, in consequence of its cancellated structure being exposed. This bone, when *in situ*, was found in contact with the posterior and most distant tine of the left antler, a portion of which, above six inches long, it had severed from its connexion with the palm."

In addition to these specimens, Dr. Carte submitted another at the May meeting, which consisted of a single antler exhibiting a deep impression on its palm, produced by a canon bone resting on it. It was perfectly evident from the facts brought before the Society, that the markings which formed the subject of the paper were produced by the fortuitous juxtaposition of the bones in the marl, and were not the result of human agency in any way. As to the exact mode in which the markings were effected—whether by friction or by pressure—and, if by the former, how the motion necessary to produce friction had arisen, various suggestions were proposed by the gentlemen who were present at the meeting.

In April Mr. Westropp gave us a paper "on a Trap Rock at Bray Head," which showed how much may still be discovered by the labours of careful observers in a district already mapped and described.

This was followed by a communication from Mr. W. H. Baily, relating to some new points in the structure of Palæchinus, which he had elicited by the examination of some specimens recently presented to the Geological Survey by Mr. M. G. Ryan. The most important new fact which he had elicited by the examination of these specimens, was the existence of a mouth opposite to the apical disc—an arrangement which proves that the Palæchinus was not attached to the ground like a crinoid, but was a free echinoderm.

At the same meeting Dr. Frazer and Captain Hutton exhibited several sections which they had prepared of serpentine and other rocks, with a view of determining whether the microscopical structure described by Dr. Dawson as "*Eozoon Canadense*," was to be discovered in the serpentines in Ireland. The gentlemen in question expressed their opinion that in the pale green serpentines of Ballynahinch in Connemara, and of Crohy Head, county of Donegal, there was a peculiar structure, quite different from that which had been detected in specimens from other Irish localities, and resembling very closely the structure in those from the Laurentian rocks of Canada.

In May, Professor Jukes gave us a paper which, with its continuation, read in December, were communications of the very greatest importance as regards the classification of the newer Palæozoic rocks. It was entitled, "Notes for a Comparison between the Rocks of the South-west of Ireland and those of North Devon, and of Rhenish Prussia in the Neighbourhood of Coblentz;" and this comparison has been carried out by the author of the paper in the greatest detail. Professor Jukes says, that he has of late come to the conclusion that the Carboniferous Slate is absolutely contemporaneous with the Carboniferous Limestone; and he exhibits this view in an ideal diagram, in which he shows the Carboniferous Slate lying side by side with the Carboniferous Lime-

stone, both lying under the Coal-measures, and upon the Old Red Sandstone. On the supposition that this contemporaneity is proved, he proceeds to examine the rocks of Devon and of Rhenish Prussia, in order to see how far their relationship to each other is explained by this hypothesis. Professor Jukes has satisfied himself that the rocks about Piltown and Marwood in North Devon are identical with those of the county of Cork, both as regards their lithological character and their fossil contents; but as to those to the north of Morte Bay he expressed his opinions in his first paper with a degree of uncertainty. In the second paper, read in December, he gave us the results of a fresh examination of the district, which he had carried out in the course of last autumn, and from which he considers himself justified in proposing the following explanation:—"That a great fault, with a downthrow to the north, strikes from the north corner of Morte Bay about east by south, all across North Devon." The evidence of this is entirely indirect, but its existence is rendered extremely probable from the following considerations:—Firstly, without some such interpretation it would be impossible to account for the enormous thickness of beds all dipping south which we meet in the district; and, secondly, along the line of the supposed fault we meet with beds corresponding to the Old Red Sandstone, while to the north of it again beds recur which contain Carboniferous Slate fossils, and yet appear to dip under the Old Red Sandstone.

While expressing the greatest respect for the views of Professor Sedgwick and Sir R. I. Murchison, in their paper on the "Physical Structure of Devonshire," Professor Jukes stated his opinion that the labours of the Survey in the South of Ireland had résulted in the discovery of what was the true key to the classification of the rocks hitherto called Devonian, and that accordingly the strata of Devonshire might be divided into the three great groups, so well known elsewhere, viz. 1, Coal-measures; 2, Carboniferous Slate or Devonian; 3, Old Red Sandstone.

As regards the rocks of the vicinity of Coblentz, Mr. Jukes did not express very decided views, but threw out some hints for the guidance of future observers.

In June Mr. W. H. Brownrigg brought before us the first notice of what we may without hesitation characterize as the most important palæontological discovery which has ever been made in Ireland. The fossils of which we speak were found at the Jarrow Colliery, near Castlecomer. Mr. Brownrigg in his paper gave us a description of the geology of the district, and more especially of the Jarrow Pit itself, reserving the results of the scientific examination of the specimens for a subsequent occasion. The remains, which were mainly Reptilian, were associated with some other specimens which have been identified by Mr. W. H. Baily. The collection of Reptilian remains has been intrusted to Professors Huxley and E. Perceval Wright; and the first portion of the description has been brought before the Royal Irish Academy, which body has most liberally voted a large sum of money for the

illustration of the specimens, so that we may hope to have the full description placed in our hands within a short space of time.

Mr. Brownrigg's opinion that the collection would turn out to contain several new genera has proved perfectly correct; and for the one species for which he proposed the specific name "Wandesfordii," the genus "Urocordylus" has been established by Professors Huxley and Wright. We cannot speak too highly of the zeal and assiduity of our Fellow, Mr. Brownrigg, and of the other gentlemen by whose unremitting exertions there has been secured from one small pit a collection of fossil Reptiles which is perfectly unique, and contains a number of genera greater than was known hitherto to exist in the Carboniferous rocks elsewhere.

When the Society reassembled in November, one of our Associates, Mr. H. P. Wall, brought before us some other fossils from the same locality; and at the same meeting Professor Haughton read an account of a meteorite which fell in the county of Tipperary, in the month of August last, and which he exhibited to the Society. We understand that by the wish of Viscount Hawarden, on whose property the stone fell, the analysis, &c., of the stone is to be laid before the Royal Irish Academy; but in the communication which was made to us there were some points of very great interest. One is, that the specimen is only a fragment apparently of a much larger stone, the remainder of which, if it reached the earth at all, has not yet been discovered; another remarkable circumstance is, that the velocity with which the stone reached the ground was so slight, that it only buried itself to a very slight depth in the soft soil of a freshly tilled field.

The December meeting was occupied in part by the second portion of Mr. Jukes's paper on the Devonian Rocks, and in part by an account which Professor Haughton gave us of a visit which he had paid in the course of the summer to Norway, and of the results of some observations which he had made on the glacier of Bondhuus, showing how that glacier differed in its type from those of Switzerland.

In January we had a brief communication from Mr. G. Henry Kinahan, "On the Foliation in the Gneiss, &c., of Yar-Connaught."

Before we close our Report, we must notice a paper which, though the last, is not by any means the least on our list. It is that announced for this evening by Mr. Harte, "On the Occurrence of Kjökkenmöddings in the County of Donegal." It was naturally to be expected that these interesting relics of pre-historic man would be discoverable here, inasmuch as they have been found in considerable abundance both in Scotland and in England, as well as on the coasts of the Danish islands; but it has been reserved for Mr. Harte to be the first to announce their discovery; and, having his description before this Society, we might almost think that the record of a Danish shell mound was being brought under our notice.

We may conclude by expressing our hope that this is only the earnest of future papers from the same pen on this subject, giving us a fuller insight into the Fauna revealed by these memorials of bygone times.

The first number of the New Series of our Journal has been published, and distributed to all of our Fellows whose subscriptions for the year 1865 were paid.

As to the financial position of the Society, it will be remembered that at the commencement of last Session we had in hands a balance of nearly £50, owing to the fact that some of our accounts had not been presented before the accounts were closed. This will account for the fact that three half-years' salary to the Assistant Secretary appears on the credit side of the balance sheet.

During the session which has just elapsed a sum of £29 15*s*., being the amount of life compositions paid in, has been invested in Government stock, while the preparation of the diploma has involved an expense of upwards of £6. Accordingly we close our account for the year with a balance of £6 in hands, and with a balance of upwards of £60 due to Mr. M. H. Gill on account of printing our "Journal."

In the Appendix will be found, as usual:—

I. A List of Fellows now on the books of the Society.

II. ,, ,, gained and lost during the year.

III. ,, Donations received during the year.

IV. ,, Societies and Institutions to whom a copy of the Journal is regularly forwarded.

V. An abstract of the Treasurer's Account for the year 1865.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF FELLOWS, CORRECTED TO JANUARY 31, 1866.

Fellows are requested to correct errors in this List, by letter to the Hon. Secretaries, 35, Trinity College, Dublin; or to the Assistant Secretary.

OFFICERS OF THE SOCIETY FOR THE YEAR 1866–67.

President.—The Earl of Enniskillen, F. R. S.

Vice-Presidents.—Alex. Carte, M. D., F. L. S.; William Andrews, M. R. I. A.; Rev. H. Lloyd, D. D., F. R. S., Vice-Provost T. C. D.; Rev. S. Haughton, M. D., F. R. S.; Joseph B. Jukes, M. A., F. R. S.

Treasurers.—Gilbert Sanders, Esq.; Samuel Downing, LL. D.

Secretaries.—Robert H. Scott, M. A.; Robert S. Reeves, M. A.

Council.—Sir Richard Griffith, Bart., LL. D.; John Kelly, Esq.; Robert Callwell, Esq.; Alphonse Gages, M. R. I. A.; B. B. Stoney, C. E.; John Barker, M. D.; John Good, Esq.; W. B. Brownrigg, Esq.; Colonel Meadows Taylor, M. R. I. A.; W. Frazer, M. D.; E. H. Bennett, M. B.; A. Macalister, M. D.; Joseph O'Kelly, Esq.; C. P. Cotton, C. E.; A. M'Donnell, C. E.; with the Honorary Officers.

Assistant Secretary.—Mr. W. J. Galbraith, 2, *Foster-place, Dublin.*

HONORARY FELLOWS.

Elected.

1844. 1. Boué, M. Ami, For. Mem., L. G. S., *Paris.*
1865. 2. Burton, Capt. R. F., H. M. Consul, *Santoz.*
1861. 3. Daubrée, M., Membre de l'Institut, 91, *Rue de Gréville, St. Germains, Paris.*
1861. 4. Delesse, M., Ingénieur des Mines, *Paris.*
1865. 5. Des Cloiseaux, M., Prof. of Mineralogy, *Jardin des Plantes, Paris.*
1861. 6. De Serres, M. Marcel, *Montpelier.*
1861. 7. Deville, M. C. Ste Claire, *Paris.*
1861. 8. Deville, M. H. Ste Claire, *Paris.*
1861. 9. De Koninck, M. L., For. Mem., L. G. S., *Liége.*
1861. 10. Geinitz, M. H. B., For. Mem., L. G. S., *Dresden.*
1863. 11. Hunt, Dr. T. Sterry, F. R. S., *Montreal.*
1844. 12. Lyell, Sir Charles, F. R. S., 53, *Harley-street, W., London.*
1861. 13. M'Clintock, Sir Leopold, R. N., 21, *Merrion-square, North.*
1844. 14. Murchison, Sir Roderick I., F. R. S., 16, *Belgrave-square, London, S. W.*
1832. 15. Sedgwick, Rev. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING FELLOWS.

1859. 1. Gordon, John, C. E., *India.*
1859. 2. Hargrave, Henry J. B., C. E., *India.*
1859. 3. Hime, John, C. E., *Ceylon.*
1858. 4. Kingsmill, Thomas W., *Hong Kong.*
1855. 5. Medlicott, Joseph, *India.*
1854. 6. Oldham, Thomas, F. R. S., *Calcutta.*

FELLOWS WHO HAVE PAID LIFE COMPOSITION.

1853. 1. Allen, Richard Purdy, 10, *Besboro'-terrace, N. C. Road.*
1861. 2. Armstrong, Andrew, 16, *D'Olier-street.*
1861. 3. Brown, Markham, *Connorree Mining Company.*
1857. 4. Carson, Rev. Joseph, D. D., F. T. C. D., *Trinity College.*

Elected.
1832. 5. Davis, Charles, M. D., 33, *York-street.*
1857. 6. Dowse, Richard, *Mountjoy-square.*
1861. 7. Fottrell, Edward, 86, *Harcourt-street.*
1862. 8. Frazer, W., M. D., 124, *Stephen's-green.*
1857. 9. Greene, John Ball, 6, *Ely-place.*
1857. 10. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1848. 11. Haughton, Rev. Professor, M. D., F. R. S., 40, *Trinity College.*
1862. 12. Henry, F. H., *Lodge Park, Straffan, Co. Kildare.*
1850. 13. Hone, Nathaniel, M. R. I. A., *St. Doulough's, Co. Dublin.*
1861. 14. Hone, Thomas, *Yapton, Monkstown, County Dublin.*
1831. 15. Hutton, Robert, F. G. S., *Putney Park, London.*
1851. 16. Jukes, Joseph Beete, F. R. S., 51, *Stephen's-green.*
1834. 17. King, Hon. James, M. R. I. A., *Mitchelstown.*
1856. 18. Lentaigne, John, M. D., *Great Denmark-street.*
1848. 19. Luby, Rev. Thomas, D. D., F. T. C. D., *Trinity College.*
1851. 20. Malahide, Lord Talbot de, F. R. S., *Malahide Castle, Malahide.*
1838. 21. Mallet, Robert, C. E., F. R. S., 1, *The Grove, Clapham-road, London.*
1846. 22. Murray, B. B., *County Survey Office, Downshire-road, Newry.*
1859. 23. Ogilby, William, F. G. S., *Liscleen, Dunmanagh, Co. Tyrone.*
1849. 24. Sidney, F. J., LL. D., 19, *Herbert-street.*
1864. 25. Symes, Richard Glascott, 51, *Stephen's-green.*
1851. 26. Whitty, John Irvine, LL. D., 35, *Lower Mount-street.*

FELLOWS WHO HAVE PAID HALF LIFE COMPOSITION.*

1854. 1. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1832. 2. Bryce, James, LL. D., F. G. S., *High School, Glasgow.*
1862. 3. Carter, T. S., *Watlington Park, Tetsworth, Oxfordshire.*
1855. 4. Clarke, Edward, M. D., 3, *Frankfort Buildings, Rathgar.*
1854. 5. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1857. 6. Crawford, Robert, C. E., *care of Messrs. Peto and Betts*, 9, *Great George's-street, Westminster, S. W.*
1861. 7. Crosbie, William, *Ardfert Abbey, Ardfert, Tralee.*
1861. 8. Dunally, Lord, *Kilboy, Nenagh.*
1856. 9. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 10. Dunraven, Earl of, F. R. S., *Adare, Co. Limerick.*
1836. 11. Enniskillen, Earl of, F. R. S., M. R. I. A., *Florence Court, Enniskillen.*
1844. 12. Esmonde, Sir Thomas, Bart., M. R. I. A., *Johnstown Castle, Wexford.*
1854. 13. Foot, Frederick J., 51, *Stephen's-green.*
1853. 14. Harkness, Professor, F. R. S., *Queen's College, Cork.*
1861. 15. Harte, W., C. E., *Buncrana, Donegal.*
1856. 16. Haughton, Lieut. John, R. A.
1850. 17. Head, Henry, M. D., 7, *Fitzwilliam-square.*
1858. 18. Hill, J., C. E., *Tullamore.*
1862. 19. Hudson, R., F. R. S., F. L. S., *Clapham Common, London.*
1865. 20. Jacob, Arthur, B. A., *Swanscombe, Kent.*
1839. 21. James, Sir H., Colonel, R.E., F.R.S., *Ordnance Survey Office, Southampton.*
1832. 22. Kearney, Thomas, *Pallasgreen, Co. Limerick.*
1857. 23. Keane, Marcus, *Beech Park, Ennis, Co. Clare.*
1835. 24. Kelly, John, 38, *Mountpleasant-square, Rathmines.*

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* EXTRACT FROM BYE LAWS.

"Any person not residing for more than sixty-three days in each year within twenty miles of Dublin, shall be a Fellow for Life, or until he comes to reside within the above distance, on paying to the Treasurers the sum of £5 5s.

"Any non-resident Life Fellow who shall reside within twenty miles of Dublin for more than sixty-three days in any one year, shall cease to be a Fellow, unless he shall either pay an additional composition of £5 5s., for shall pay a subscription of 10s. 6d. for each year in which he shall so reside for more than sixty-three days."

Elected.
1853. 25. Kinahan, George H., 28, *D'Olier-street.*
1862. 26. Kincaid, Joseph, Jun., C. E., 9, *Spring-gardens, London, S. W.*
1838. 27. Larcom, Major-General Sir Thomas, R. E., LL. D., F. R. S., *Phœnix Park.*
1858. 28. Leech, Lieut.-Colonel, R. E., 3, *St. James's-square, London, S. W.*
1840. 29. Lindsay, Henry L., C. E., *Melbourne, care of J. Bower, Esq., C.E.,* 28, *South Frederick-street.*
1840. 30. Montgomery, James E., M. R. I. A.
1856. 31. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grinlay and Co.,* 3, *Cornhill, London.*
1856. 32. Medlicott, Henry B., F. G. S., *Geological Survey of India, per Smith and Elder, Cornhill, London, E. C.*
1857. 33. M'Ivor, Rev. James, *Rectory, Moyle, Newtownstewart, Co. Tyrone.*
1865. 34. Morton, G. H., 7, *London-road, Liverpool.*
1845. 35. Neville, John, C. E., M. R. I. A., *Dundalk.*
1852. 36. O'Kelly, Joseph, 51, *Stephen's-green.*
1832. 37. Renny, Henry L., R. E., *Canada.*
1865. 38. Scott, J. M., *Bengal Presidency College, Calcutta.*
1854. 39. Smyth, W. W., F. R. S., *Jermyn-street, London.*
1865. 40. Steele, Rev. W., *Portora Royal School, Enniskillen.*
1857. 41. Tait, Alexander, C. E., *Queen's Elms, Belfast.*
1832. 42. Tighe, Right Hon. William, *Woodstock, Innistiogue.*
1864. 43. Waller, G. A., *St. James's-gate.*
1853. 44. Webster, William B., 104, *Grafton-street.*
1861. 45. Whitney, C. J., *Brisbane, Queensland.*
1846. 46. Willson, Walter, 51, *Stephen's-green.*
1854. 47. Wyley, Andrew, 51, *Stephen's-green.*
1857. 48. Wynne, Arthur B., F. G. S., 51, *Stephen's-green.*

ANNUAL FELLOWS.

1861. 1. Andrews, William, *Messrs. Armit and Co., Nassau-street.*
1831. 2. Apjohn, James, M. D., F. R. S., *South-hill House, Blackrock.*
1857. 3. Baily, W. H., F. G. S., 51, *Stephen's-green.*
1857. 4. Bandon, Earl of, D. C. L., *Castle Bernard, Bandon, Co. Cork.*
1859. 5. Barker, John, M. B., 83, *Waterloo-road.*
1861. 6. Barrington, C. E., *Fassaroe, Bray.*
1862. 7. Barrington, E., *Fassaroe, Bray.*
1862. 8. Barton, H. M., 5, *Foster-place.*
1864. 9. Bateman, C. W., LL. B., 19, *Lombard-street, Waterford.*
1859. 10. Battersby, Francis, M. D., 15, *Warrington-place.*
1844. 11. Bective, Earl of, *Headfort, Kells.*
1862. 12. Bennett, E., M. B., 2, *Upper Fitzwilliam-street.*
1857. 13. Bolton, George, Jun., 6, *Ely-place.*
1861. 14. Bolton, H. E., 5, *Clonskea-terrace.*
1864. 15. Bradshaw, G. B., *Leahy's-terrace, Sandymount.*
1831. 16. Brady, Right Hon. Maziere, Chancellor, 26, *Upper Pembroke-street.*
1861. 17. Brownrigg, W. B., 18, *Adelaide-road.*
1840. 18. Callwell, Robert, M. R. I. A., 25, *Herbert-place.*
1857. 19. Carte, Alexander, A. M., M. D., F. L. S., *Royal Dublin Society.*
1862. 20. Close, Rev. Maxwell, *Newtownpark, Blackrock.*
1858. 21. Cotton, Charles P., C. E., 11, *Lower Pembroke-street.*
1862. 22. Cousins, A. L., *Strandville, Clontarf.*
1834. 23. Croker, Charles P., M. D., 7, *Merrion-square, West.*
1863. 24. Crook, Rev. R., LL. D., 2, *St. John's-road, Sandymount.*
1846. 25. D'Arcy, Matthew, M. R. I. A., *Anchor Brewery, Ussher-street.*
1853. 26. De Vesci, Lord, *Abbeyleix House, Abbeyleix.*
1863. 27. Dixon, G., 10, *Burlington-road.*
1849. 28. Downing, Samuel, C. E., LL. D., 6, *Trinity College.*

Elected.

1852. 29. Doyle, J. B., *The Mansion, Ballycastle.*
1865. 30. Fleming, John M., *Royal Engineers' Department, Royal Barracks.*
1857. 31. Frith, R. J., C. E., *Leinster-road, Rathmines.*
1858. 32. Gages, Alphonse, M. R. I. A., 51, *Stephen's-green.*
1864. 33. Gahan, A., C. E., *Omagh.*
1849. 34. Galbraith, Rev. Joseph A., F. T. C. D., *Trinity College.*
1864. 35. Garnett, A. C., 5, *Mountjoy-square, N.*
1865. 36. Gibson, John, C. E., *Stapleton-place, Dundalk.*
1865. 37. Gray, R. A., C. E., 5, *Palmerston Villas, Upper Rathmines.*
1859. 38. Green, Murdock, 52, *Lower Sackville-street.*
1862. 39. Gribbon, C. P., 72, *Stephen's-green.*
1831. 40. Griffith, Sir R., Bart., LL. D., F. G. S., 2, *Fitzwilliam-place.*
1856. 41. Good, John, *City-quay.*
1857. 42. Hampton, Thomas, C. E., 6, *Ely-place.*
1861. 43. Hudson, A., M. D., *Merrion-square.*
1865. 44. Hutton, T. M., 118, *Summer-hill.*
1834. 45. Hutton, Thomas, F. G. S., 116, *Summer-hill.*
1852. 46. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 9, *Trinity College.*
1842. 47. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1861. 48. Johnston, C. F., 9, *Eustace-street.*
1862. 49. Kinahan, G., J. P., *Roebuck-hill, Dundrum.*
1865. 50. Leech, James, C. E., 6, *Ely-place.*
1831. 51. Lloyd, Rev. Humphrey, D. D., F. R. S., Vice-Provost T. C. D., 35, *Trinity College.*
1863. 52. Macalister, A., M. D., 10, *Gardiner's-place.*
1855. 53. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1861. 54. M'Comas, A., 23, *Rathmines-road.*
1865. 55. M'Donnell, Alexander, C. E., *St. John's, Inchicore.*
1851. 56. M'Donnell, John, M. D., 4, *Gardiner's-row.*
1852. 57. Mac Donnell, Rev. Richard, D. D., Provost of Trinity College, *Provost's House, Trinity College.*
1837. 58. Mollan, John, M. D., 8, *Fitzwilliam-square, North.*
1859. 59. Moore, Joseph Scott, J. P., *Hume-street.*
1862. 60. Moore, Stephenson C., *Kenilworth-villa, Rathmines.*
1831. 61. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 62. O'Brien, Octavius, 23, *Kildare-street.*
1865. 63. Ollis, G., *Royal Engineers' Department, Royal Barracks.*
1863. 64. Ormsby, M. H., 16, *Fitzwilliam-square.*
1864. 65. Palmer, Sandford, *Roserea.*
1865. 66. Porte, G., *Beggarsbush-road.*
1857. 67. Porter, William, C. E., *Leinster Club, Clare-street.*
1865. 68. Radley, John, *Gresham Hotel, Sackville-street.*
1864. 69. Reynolds, Emerson J., *Booterstown, Co. Dublin.*
1857. 70. Reeves, R. S., 22, *Upper Mount-street.*
1861. 71. Roberts, W. G., *Ballinapark, Ovoca.*
1862. 72. Rowan, D. J., C. E., *Dundalk.*
1864. 73. Russell, H., *Simmon's-court.*
1852. 74. Smith, Robert, M. D., 63, *Eccles-street.*
1852. 75. Sanders, Gilbert, M. R. I. A., 2, *Foster-place.*
1854. 76. Scott, Robert H., A. M., 48, *Wellington-place.*
1864. 77. Scovell, F., *Trafalgar-terrace, Monkstown.*
1859. 78. Stokes, William, M. D., F. R. S., 5, *Merrion-square, N.*
1861. 79. Stoney, Bindon, C. E., 42, *Wellington-road.*
1862. 80. Taylor, Colonel Meadows, M. R. I. A., *Old-court, Harold's-cross.*
1864. 81. Tichbourne, C. R. C., *Apothecaries' Hall, Mary-street.*
1862. 82. Trench, W. R., *University Club, Stephen's-green.*
1859. 83. Waldron, L., M. P., LL. D., *Ballybrack, Dalkey.*
1859. 84. Walker, William F., A. M., 9, *Trinity College.*

Elected.
1863. 85. Westropp, W. H. S., M. R. I. A., 2, *Idrone-terrace, Blackrock.*
1863. 86. Williams, R. P., 38, *Dame-street.*
1851. 87. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1864. 88. Wright, Joseph, 39, *Duncan-street, Cork.*

ASSOCIATES FOR THE YEAR.

1. Babington, George, 29, *Trinity College.*
2. Bayly, George, 12, *do.*
3. Cotton, R. M., 24, *do.*
4. Duffin, W. L., 11, *do.*
5. Faris, Charles, 34, *Leeson-street.*
6. Grubb, H., 141, *Leinster-road.*
7. Petherick, James, 29, *Trinity College.*
8. Reed, James, 17, *Corrig-avenue.*
9. Smith, F., 71, *Lower Baggot-street.*
10. Thorp, Charles R., 39, *Kildare-street.*
11. Wall, H. P., 16, *Trinity College.*
12. Waring, Charles, 11, *do.*

No. II.

LIST OF FELLOWS GAINED AND LOST,

During the Year ending January 31, 1866.

FELLOWS GAINED.

Honorary.

1. M. Des Cloiseaux, Professor of Mineralogy, *Jardin des Plantes, Paris.*
2. Burton, Captain R. F., H. M. Consul, *Santoz.*

Half Life.

1. Jacob, Arthur, B. A., *Swanscombe, Kent.*
2. Morton, G. H., 7, *London-road, Liverpool.*
3. Scott, J. M., *Bengal Presidency College, Calcutta.*
4. Steele, Rev. W., *Portora Royal School, Enniskillen.*

Annual.

1. Fleming, John M., *Royal Engineers' Department, Royal Barracks.*
2. Gibson, John, C. E., 1, *Carlisle-terrace, Sandymount.*
3. Gray, R. A., C. E., 5, *Palmerston Villas, Upper Rathmines.*
4. Hutton, Thomas M., 118, *Summer-hill.*
5. Leech, James, C. E., 6, *Ely-place.*
6. M'Donnell, Alexander, C. E., *St. John's, Inchicore.*
7. Ollis, G., *Royal Engineers' Department, Royal Barracks.*
8. Porte, G., *Beggarsbush-road.*
9. Radley, John, *Gresham Hotel, Sackville-street.*

FELLOWS LOST.

Life.

1. Connolly, John, *Artane.* Deceased.
2. Hamilton, Sir W. R., *Dunsink.* Do.

Half Life.

1. Haughton, John Hancock, *Carlow.* Deceased.
2. Palmerston, Lord Viscount, *London.* Do.

Annual.

1. Hutton, Edward, M. D., *Merrion-square.* Deceased.
2. Kinahan, Thomas, *Carlisle-buildings.* Resigned.
3. M'Dowell, George, *Trinity College.* Deceased.
4. Ryan, George, *S. Frederick-street.* Resigned.

Removed from List, for Non-payment of Subscription.

1. Barton, F., *Grattan-street.*
2. Humphrey, H. T., *Merrion.*
2. Lyster, J., *Stillorgan.*

State of the Society at the commencement of—

	Year 1865.	Year 1866.
Honorary Fellows,	13	15
Corresponding do.,	6	6
Life do.,	74	74
Annual do.,	86	88
	179	183

No. III.

DONATIONS RECEIVED TO JANUARY 31, 1866.

Amsterdam.—Kon. Akademie van Wettenschappen, Verslagen en Mededeelingen, Vol. XVII.
——— Verhandelingen, Part X.
——— Jaarboek, 1863-64.
Berlin.—Deutsche Geologische Gesellschaft, Zeitschrift, Vol. XVI., Parts 3, 4; XVII., 1, 2.
Bologna.—Accademia delle Scienze dell' Istituto, Memorie, Tom. III., 1–4; IV., 1.
——— Rendiconto delle Sessione, 1863–64.
——— Indici Generali, 1850-61.
Brünn.—Naturforschende Verein, Verhandlungen, Vols. III., IV.
Brussels.—Academie Royale, Annuaire, 1865.
——— Bulletin, 1864–65.
Caen.—Société Linnéenne de Normandie, Bulletin, Vol. IX.
Cambridge, U. S. A.—Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College.
Canada.—Geological Survey of, Decade III., the Graptolites of the Quebec Group. By Prof. James Hall. From Sir W. Logan, Director-General.
Dijon.—Academie Impériale des Sciences, Arts, et Belles Lettres, Mémoires, Vol. XI.

Dublin.—The Dublin Quarterly Journal of Science, Nos. 17-20. From the Editor, the Rev. Samuel Haughton, M.D.
——— Royal Dublin Society, Journal, Nos. 32-33.
——— Royal Irish Academy, Proceedings, Vol. VIII., Part 7; IX., Parts 1-3.
——— Natural History Society, Transactions, Vol. IV., Part 2.
——— Catalogue of Published Maps, &c., of the Geological Survey of the United Kingdom, up to March, 1865.
——— Explanations to Sheets 98, 99, 108, 109, 115, 116, 167, 168, 178, 179, 192, 199; and to Horizontal Sections 17-18 of the Geological Survey of Ireland.
——————— Sheets 98, 108, 115, 116, 166.
——————— Horizontal Sections, 17, 19, 20.
From Sir R. Murchison, Director-General.
——— Institution of Civil Engineers', Transactions, Vols. I.-IV., VII., Part 2.
——— Dublin University Zoological and Botanic Association, Proceedings, Vol. II., Part 2.
Edinburgh.—Royal Scottish Society of Arts, Transactions, Vol. VII., Part 1.
Frankfort.—Zoologische Gesellschaft. Das Zoologische Garten, Parts 1-12.
Falmouth.—Royal Cornwall Polytechnic Society, Annual Report, 1864.
Glasgow.—Geological Society, Transactions, Vols. I., Part 2; II., Part 1.
Halle.—Naturwissenschaftliche Verein für Sachsen und Thüringen in Halle. Zeitschrift für die gesammten Naturwissenschaften. Vols. XXIV., XXV.
Kilkenny.—Kilkenny and South-East of Ireland Archæological Society, Proceedings and Papers. Nos. 45-48.
Königsberg.—K. Physikalisch-Œkonomische Gesellschaft, Schriften, 1864, Parts 1, 2.
Liverpool.—Historic Society of Lancashire and Cheshire, Transactions, 1863-64.
——— Literary and Philosophical Society, Proceedings, No. 18.
——— Geological Society, Proceedings, 1864-65.
Lausanne.—Société Vaudoise des Sciences Naturelles, Bulletin, 50-52.
London.—Report of Commissioners appointed to Inquire into the Condition of all Mines in Great Britain, with Minutes of Evidence taken by ditto. Presented by the Earl of Enniskillen.
——— Geological Society, Quarterly Journal, Parts 81-84.
——— Royal Geographical Society, Journal, Vol. XXXIV.
————————————— Proceedings, Vol. IX., Parts 2-6; X., Part 1.
——— Royal Institution of Great Britain, Notices of Proceedings. Vol. IV., Part 6.
——— Royal Society, Proceedings, Nos. 70-78.
——— British Association Report, Bath, 1864.
——— Linnean Society, Journal of Proceedings.
——————— Botany, Vol. VIII., IX., to Part 36.
——————— Zoology, Vol. VIII., IX., to Part 33.
——— Zoological Society, Proceedings, 1864, Parts 1-3.
——— Geologists' Association, Annual Report, 1865.
——— The Mining and Smelting Magazine, Nos. 38-39.
——— Institution of Civil Engineers, Minutes of Proceedings, Vol. XXI., and Index to Vols. I.-XX.
Lyons.—Academie Impériale des Sciences Belles Lettres et Arts, Memoires, Classe des Sciences, VIII.
——— Lettres, XI.
——————— Bulletin des Séances, 1865.
——— Société Imp. d'Agriculture, etc. Annales des Sciences Physiques et Naturelles, Vol. VII.
Madrid.—R. Academia di Ciencias, Memorias, Ciencias Fisicas, Vol. II., Parts 1, 2.
——————— Resumen de las Actas, &c., de la R. Academia, 1862-63.
——— Libros del Saber de Astronomia del Rey Alfonso de Castilla, Vol. III.
Manchester.—Manchester Geological Society, Transactions, Vol. V., Parts 2-7, 10-12.
Milan.—Reale Istituto Lombardo de Scienze, Rendiconti, Vols. I., Parts 4-10; II., Parts 1, 2.
——————— Memorie, Vol. X., Part 1.

Milan, Reale Istituto, &c., Annuario, 1864.
———— Solenni Adunanze, Aug., 1864.
——— Societa Agraria di Lombardia, L'Agricoltura, 8–16, 20–28.
Montreal.—Natural History Society, the Canadian Naturalist and Geologist, Vol. II., Parts 1–4.
Munich.—K. Baierische Akademie der Wissenschaften, Sitzungs-berichte, 1865, Vol. I., Parts 1–2; II., Parts 1–2; 1864, II., 2–4.
———— Induction and Deduction. By Baron von Liebig.
———— Enstehung und Begriff der Naturhistorischen Art. By Dr. Carl Nägeli.
Newhaven.—The American Journal of Science and Art, Nos. 115–120. From the Editors.
New York.—Lyceum of Natural History, Charter, &c.
———— Annals, Vol. VIII., Parts 1–3.
Palermo.—Accademia di Scienzi e Lettere, Atti, Vol. II.
Philadelphia.—Academy of Natural Sciences, Proceedings, 1864.
——— American Philosophical Society, Proceedings, Vol. IX., Parts 71, 72; X., Part 73.
———— Transactions, Vol. XIII., Part 2.
———— Catalogue of Library, Part I.
Plymouth.—The Institution, Report of the Transactions, 1864–65.
Quebec.—Literary and Historical Society, Transactions, 1864–65.
Toronto.—Canadian Institute. The Canadian Journal of Industry, Science, and Art, Nos. 55-60.
Stuttgart.—Verein für Vaterländische Naturkunde. Würtembergische Naturwissenschaftliche Jahreshefte, 1858–1865.
Truro.—Royal Institution of Cornwall, Journal, No. 2, March, 1865.
Vienna.—K. K. Geologische Reichsanstalt, Jahrbuch, XIV., 2; XV., 1–2. From the Director, Prof. Haidinger.
——— K. K. Zoologisch Botanische Gesellschaft, Verhandlungen, 1855–64.
———— Bericht über die Oesterreichische Literatur der Zoologie, Botanik, und Palæontologie, 1850, 1–3.
———— Register der Abhandlungen etc, 1857.
———— Nachträge zu Maly's "Enumeratio Plantarum," 1861.
Washington.—Smithsonian Institution, Report, 1863.
———— Results of Meteorological Observations, 1854–59.

PRESENTED BY THE AUTHORS.

Binney (E. W., F. R. S.)—Further Observations on the Permian and Triassic Strata of Lancashire.
——— A few Remarks on Mr. Hull's Additional Observations on the Drift Deposits in the Neighbourhood of Manchester.
——— A Description of some Fossil Plants, showing Structure, found in the Lower Coal Seams of Lancashire and Yorkshire.
Haast, Julius (F. G. S.)—Report on the Geological Survey of the Province of Canterbury, of Lancashire, and Yorkshire.
——— Report on the Formation of the Canterbury Plains, with Sketch Map.
——— Report of the Geological Exploration of the West Coast of New Zealand.
——— Report of the Geological Formation of the Timaru District, in reference to the Supply of Water.
Hull, Edward (B. A.)—Additional Observations on the Drift Deposits, and more recent Gravels, in the Neighbourhood of Manchester.
Kjerulf (T.)—Veiviser ved Geologiske Excursioner i Christiania Omegn.
Murchison, Sir R. I.—On the Laurentian Rocks of Britain, Bavaria, and Bohemia.
Sars, Michael.—Om de i Norge Forekommende Fossile Dyrelevninger Fra Quartærperioden et Bidrag til vor Faunas Historie.
Winchell (Prof. A.)—Some Indications of a Northward Transportation of Drift Materials in the Lower Peninsula of Michigan.

No. IV.

SOCIETIES AND INSTITUTIONS TO WHICH THE JOURNAL OF THE ROYAL GEOLOGICAL SOCIETY OF IRELAND IS SENT.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
ANTWERP, .	Société Palæontologique de Belgique.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geographical Society.
	German Geological Society, per Besser'sche Buchhandlung, *Behrenstr* 7, *Berlin*.
BOLOGNA, .	Accademia delle Scienzi dell' Istituto.
BORDEAUX, .	Imperial Academy of Sciences.
BOSTON, . .	American Academy.
	Natural History Society.
BRISTOL, . .	Institution for the Advancement of Science, Literature, and the Arts.
BRÜNN, . .	Naturforschende Verein.
BRUSSELS, .	Academy of Sciences.
CAEN, . . .	Société Linnéenne de Normandie.
CALCUTTA, .	Asiatic Society.
	Public Library.
	Geological Survey of India.
CAMBRIDGE, .	Philosophical Society.
	Trinity College Library.
CANTERBURY, NEW ZEALAND,	Geological Survey.
COPENHAGEN,	Royal Society of Science.
CORK, . . .	Queen's College Library.
	Royal Institution.
DIJON, . . .	Academy of Sciences.
DRESDEN, . .	The "Isis" Society.
DUBLIN, . .	Royal College of Surgeons' Library.
	Royal Irish Academy.
	University Library.
	Royal Dublin Society.
	Natural History Society.
	Ordnance Survey Library.
	Professor Sullivan, as Editor of the "Atlantis."
	Geological Survey of Ireland.
	Institution of Civil Engineers.
EDINBURGH, .	Royal Society.
	Wernerian Society.
	Royal Scottish Society of Arts.
	University Library.
	Society of Antiquaries.
	Advocates' Library.
FALMOUTH, .	Royal Cornwall Polytechnic Society.
FLORENCE, .	Society of Physics and Natural History.
GALWAY, . .	Queen's College Library.
GENOA, . .	Society of Physics.
GLASGOW, . .	University.
	Geological Society.
GÖTTINGEN, .	University.
HAARLEM, .	Société Hollandaise des Sciences, per B. Quarritch, 15, *Piccadilly*, *London*.

HALLE, . . Naturwissenschaftliche Verein für Sachsen und Thüringen, per Antons Buchhandlung, *Halle.*
HANAU, . . Oberhessische Gesellschaft der Natur-und Heil-kunde.
HANOVER, . Royal Library.
KILKENNY, . Archæological Society.
KÖNIGSBERG, Königlich Physikalisch-Oekonomische Gesellschaft.
LAUSANNE, . Société Vaudoise des Sciences Naturelles.
LEEDS, . . Geological and Polytechnic Society of the West Riding of Yorkshire.
Philosophical and Literary Society.
LEIPZIC, . . Royal Society of Sciences (Saxony).
University.
LIVERPOOL, . The Literary and Philosophical Society.
Historic Society of Lancashire and Cheshire.
Geological Society, The Royal Institution, *Colquitt-street.*
LONDON, . . Geological Survey, *Jermyn-street.*
British Museum.
Society of Arts, *John-street, Adelphi.*
Royal Institution, *Albemarle-street.*
Royal Society, *Burlington House.*
Geological Society, *Somerset House.*
Linnean Society, *Burlington House.*
Royal Geographical Society, 15, *Whitehall-place.*
Civil Engineers, Institution of, 25, *Great George's-street, Westminster.*
Royal Asiatic Society, 5, *New Burlington-street.*
Royal College of Surgeons, *Lincoln's Inn.*
Zoological Society, 11, *Hanover-square.*
Athenæum, 14, *Wellington-street, Strand, London, W. C.*
Anthropological Society, 4, *St. Martin's-place, London, W. C.*
LYONS, . . La Société Impériale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
Société Linnéenne.
Academie Impériale, per Treuttel & Würtz, 19, *Rue de Lille, Paris.*
MADRID, . . Academia de Ciencias.
MANCHESTER, Literary and Philosophical Society of. [Sec., R. C. Christie.]
Geological Society.
MELBOURNE, . Philosophical Institute of Victoria.
The Public Library, per Bain and Co., 1, *Haymarket, London.*
The Royal Society.
MILAN, . . Reale Istituto Lombardo di Scienzi.
MISSOURI, . . State Survey and University, *Geological Rooms, Columbia, U. S. A.*
MODENA, . . Imperial Institute of Science.
MONTREAL, . Natural History Society.
MUNICH, . . Royal Academy of Science (2 copies).
NEUCHATEL, . Société des Sciences Naturelles.
NEWHAVEN, U. S. A., The Editors of Silliman's Journal of Science and Art.
OXFORD, . . Bodleian Library.
Ashmolean Society.
PALERMO, . Accademia di Scienzi e Lettere.
PARIS, . . Ecole Polytechnique.
Geological Society.
L'Ecole Impériale des Mines.
Institute of France.
Bibliothéque Impériale.
Jardin des Plantes, Bibliothéque.
PHILADELPHIA, American Philosophical Society.
Academy of Natural Sciences, per Trübner and Co.
PLYMOUTH, . Plymouth Institution and Devon and Cornwall Natural History Society.
PRESBURG, . Verein für Naturkunde.

QUEBEC, . .	Literary and Historical Society.
ROME, . . .	The Vatican Library.
ROUEN, . .	Academy of Science.
ST. ANDREWS,	University Library.
ST. LOUIS, . .	Academy of Sciences.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
	Russisch-Kaiserliche Mineralogische Gesellschaft.
STOCKHOLM, .	Royal Academy of Science, per Longman and Co., *Paternoster-row, London*; and Sampson and Wallis, *Stockholm*.
STRASBOURG, .	Société des Sciences Naturelles.
STUTTGART, .	Verein für vaterländische Naturkunde.
TORONTO, C.W.,	Canadian Institute, per Thomas Henning, Esq.
TOULOUSE, .	Academy of Sciences.
TRURO, . .	Royal Institution of Cornwall.
TURIN, . .	Royal Academy.
UPSALA, . .	Royal Society of Sciences.
VIENNA, . .	Imperial Academy of Sciences.
	Prof. W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichs-anstalt."
	K. K. Zoologisch-botanische Gesellschaft, per Braumüller & Co., *Vienna*.
WASHINGTON,	Smithsonian Institute Library, per W. Wesley, Esq., 2, *Queen's Head Passage, Paternoster-row, London, E. C.*
WINDSOR, .	The Royal Library.
ZURICH, . .	Naturforschende Gesellschaft.

No. V.

ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1865.

1865.—Dr.				£	s.	d.
To Balance from last year's Account,				46	6	9
— Amount of Subscriptions received for year ending December 31, 1865, viz.—						
— Life Compositions,	£29	15	0			
— Entrance Fees,	11	19	0			
— Annual Subscriptions,	92	10	0			
				134	4	0
— Amount of Dividend for one half-year on Government Stock,				1	10	0
— Cash received for sale of Journal, per Messrs. Hodges and Smith,				2	12	6
				£184	13	3

1865.—Cr.				£	s.	d.
By Assistant Secretary, Half-year's Salary, to December 31, 1864,				10	0	0
— Messrs. Foster and Co., for Lithographs,	£6	12	6			
— Messrs. Williams and Norgate, for Carriage,	2	14	10			
— M. H. Gill, on account,	6	19	0			
				16	6	4
— Ditto, Account for Printing Journal,				35	0	0
— Assistant Secretary, Half-year's Salary, to June 30, 1865,				10	0	0
— Porter's Wages,	7	17	6			
— M. Ward and Co. (Diploma),	6	12	6			
— Mr. J. Walsh, for Woodcuts,	1	0	0			
— Sundries (as per Book),	14	15	11			
				30	5	11
— Porter's Wages,	5	0	0			
— Palæontographical Society (Subscription),	1	1	0			
— Hanlon for Engravings,	4	0	0			
— Sundries (as per Book),	2	3	7			
				12	4	7
— Porter's Wages,	1	12	6			
— Sundries (as per Book),	3	11	9			
				5	4	3
— Assistant Secretary, Half-year's Salary to December 31, 1865,				10	0	0
— M. H. Gill, on Account for Printing Journal,				20	0	0
— Invested in Government Stock,				29	15	0
— Balance to next Account, in Bank,				3	8	11
— Cash in Treasurer's hands,				2	8	8
				£184	13	3

We have examined the foregoing Account, and compared vouchers, and find that a balance remains to the credit of the Society of £5 17s. 7d.

(Signed) ROBERT CALLWELL.
B. B. STONEY.

Audited January 31, 1866.

MINUTES OF PROCEEDINGS FOR THE YEAR 1865–66.

March 8, 1865.

A. Carte, Esq., F. L. S., Vice-President, in the Chair.

The Minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

W. E. L'Estrange Duffin, Esq., 11, Trinity College, Dublin, was elected an Associate for this Session.

A resolution of Council was read, recommending that M. Descloiseaux, of Paris, be elected an Honorary Fellow.

On the motion of M. Gages, seconded by Mr. Jukes, the recommendation of Council was unanimously adopted.

Mr. Scott read a paper by Mr. W. Harte, C. E., Donegal, "On some Crumpled Granite Beds from the County of Donegal" (p. 144).

Mr. Scott observed that Mr. Harte was a very careful observer, who, as they well knew, had added much to their knowledge of the geology of the county. His own recollection of the immediate locality referred to by Mr. Harte was that there was a considerable amount of schist included in the granite; and at one locality at no great distance, called Toberkeen, there was a bed of limestone which contained an abundance of garnet and idocrase, indicating considerable metamorphic action. The granite about Dungloe, and in the Rosses generally, was very coarse-grained; and it was highly interesting that Mr. Harte should have found it to be contorted.

Mr. Bolton said that he had accompanied Mr. Harte, when that gentleman was making his observations at Dungloe, and that he could testify to their accuracy. He had particularly noticed the sharp ends of the cracks as indicated on the diagram, and he was of opinion that the slickenside appearance of the surfaces was produced by motion.

Mr. Close differed from Mr. Bolton as to the explanation of this particular structure by supposing a motion of the rock. He had himself exhibited to the Society, two years ago, a specimen of granite, a small triangular prism, in which the striations went round the prism, not along it. This could hardly be explained by the hypothesis of motion, as that motion must have taken place in three planes.

Mr. Jukes then took the Chair, while Dr. Carte read a paper "On some Indented Bones of the *Cervus megaceros*, found near Lough Gur, county of Limerick" (p. 151).

Dr. Carte then showed how accurately the bones fitted into the grooves, and how parts of them were polished. He said that in a former discussion upon a paper by Professor Jukes relating to bones of the *Cervus megaceros* found under circumstances similar to the present, the differences of opinion resolved themselves into three theories:—Mr. Jukes held that the abrasions were produced by simple pressure, and that there had been no such thing as friction; another theory was, that the marks were actually produced by the hand of man; the third theory was, that they were the result of the friction of the bones lying upon one another, that friction having been produced by motion for which it was not easy to assign a cause. The last was the doctrine that he himself broached, and he thought he would be able to show that his view was borne out in a very remarkable manner by the specimens now before them.

Dr. Battersby—Were the bones found lying close upon the horns in the way you have described?

Dr. Carte—Quite so. The man sent them up as he got them in the bog, marking the different parts which were in contact.

Professor Jukes said they must all be excessively obliged to Dr. Carte for these interesting specimens. It was evident that as the animal died, the bones in question fell in a confused mass to the bottom of some lake or water, and that lying upon one another they got abraded in the way that was seen. In the former discussion his sole point was

that the marks could not have been produced by the hand of man, and that therefore the specimens then adduced could not be pointed to as evidence of the existence in Ireland of man contemporaneously with the *Cervus megaceros*. They knew that man did exist contemporaneously with that animal in England; and then arose the geological question, was Ireland at that time already separated from England and the Continent? Was the great plain which formerly connected the British Islands with the Continent already worn away, or had man already crossed over from England to Ireland? They knew that man existed in England probably before England was separated from the Continent. There was little difference between Dr. Carte and himself as to the exact cause of the indentations. Dr. Carte's idea was, that a little motion of the bones took place, and that friction was the consequence. For his part, he would be glad to be able to conclude that there had been friction; but the possibility of it seemed taken away by the facts stated in the paper, that the marl was like cheese, with clay and stones underneath it, and that the bones were so firmly imbedded in the marl that it was difficult to get the horns out without breaking them. It was difficult to conceive what motion there could have been with sixty feet of turf over the marl; but that was a physical question, on which he gave no opinion. The Knight of Kerry had suggested to him that great storms might have given a tremulous motion to the bog, which might have been transmitted downwards. Dr. Carte misunderstood him as to one point. He by no means supposed that the marks were caused merely by squeezing or pressure. What he did suggest was, that the parts squeezed might have been dissolved, and altogether removed. It was, satisfactory, however, with regard to the present specimens, that they did not for a moment admit the possibility of the indentations having been caused by the hand of man.

Dr. Frazer observed that at present red deer, in their search for food, often ran one after another into bogholes, and were smothered; and that there might have been marshy ground and a lake in this locality when these animals had lived there—perhaps three or four feet of marl, and a lake above it—into which the animals had fallen, and were drowned.

Mr. Scott observed that Hinchy, who had found the bones, had great experience in the discovery of specimens of the Megaceros; and that, when his attention had been directed to the circumstance that bones of this animal frequently exhibited markings, he at once said that he had often seen bones marked by lying together in the ground. He accordingly sent up the specimens now exhibited, and which were seen *in situ* not only by himself, but by Dr. Bennett, the gentleman who was with him on that day. It was certainly very remarkable that so many (upwards of seventy) heads had been discovered in so small a space within the last thirty years, and it appeared that there were still a good many left there.

Mr. Bolton was of opinion that the indentations had been caused by friction, resulting from motion of the bones against each other. He had seen the bough of a tree which was acted on by another piece of wood in water, in which there was a very slight motion, almost cut in two in a couple of days. The small, fine, sharp particles of the marl, getting between the bones, would have aided the process very much.

Captain Hutton observed that, as the two bones had cut into the antler in directions not parallel to each other, it was evident that no lateral motion of the antler could have taken place; and it was difficult to conceive any movement of the marl, or superjacent bog, which would give the two bones motions in different directions; and, as one of the bones appeared to have cut its way up, and the other down, it seemed to him that the markings must be due either to simple pressure, or to a slight vertical movement.

The Chairman was of opinion that, in the case of the bones from Legans, where the bones fell at first, there was then an open lake, without any bog or peat whatever near. The existing bed of marl in which they had been discovered was formed by the shells and *debris* of the animals that lived in the lake, and must have taken hundreds of years to accumulate. It was now covered by forty or fifty feet of bog, which extended for miles in every direction; and the subsequent formation of that bog must have taken even thousands of years. Portions of the bones in question which had projected into the peat rotted away; and the circumstance of their having been imbedded in the marl was what preserved the rest. He thought that pressure was the likeliest way of accounting for the indentations.

Dr. Macalister said, the great objection to the theory of pressure was that it would have shown the fibres of the bones bent, and not cut, as they appeared to have been. The polishing might be due to the fine particles of marl; but, if the latter had assisted in the cutting, the indentations and the bones corresponding to them would not fit as they did.

Captain Hutton said that, although a bog might shake at the top, there would be very little motion beneath its surface. It was well known that in a gale of wind the sea is quite still at eight or ten fathoms beneath the surface.

Mr. Good was decidedly in favour of the friction theory. The smallest motion in water causing friction, suppose of a broken mast or spar, against the side of a ship, would rapidly produce a cutting, the edges of which would be rough and jagged, or quite fine and smooth, according as the wood acted on was soft or hard.

Dr. Bennett observed, that what had been adduced at this meeting seemed to exclude the supposition of human hands having produced the indentations. He believed that, whatever was the force that did so, it must have been in action up to the very day the bones were found. He did not believe that such beautifully-polished surfaces as the bones exhibited could have been produced in a place saturated with water, and exposed to the deposit of mineral salts. There was no evidence that the bones were ever under running water. The only point that he referred to in last year's discussion was the supposition that the markings in the bones then exhibited were the result of disease. Dr. Carte's present specimens excluded that supposition altogether.

Mr. Brownrigg observed that the motion of the bones, while in the soft marl, might have been owing to variation in the weight of water over it, caused by the alternate floods of winter and droughts of summer, which would have produced successive compressions and relaxings. This action, going on for an immense number of years, might have been adequate to the production of the effects.

Dr. Carte replied briefly, saying that the gentlemen who had taken part in the discussion had answered each other, so that there was little left for him to say, excepting to express his satisfaction that the specimens which he submitted to them had given rise to so animated a discussion.*

The meeting then adjourned.

April 12, 1865.

A. Carte, M.D., F.L.S., Vice-President, in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

A recommendation from the Council was brought forward that Captain R. F. Burton, Her Majesty's Consul at Santoz, be elected an Honorary Fellow; and the motion, having been proposed by Captain Taylor, and seconded by Professor Jukes, was carried unanimously.

Mr. W. H. S. Westropp read a paper "On a Trap Rock at Bray Head, County Wicklow" (p. 149).

Professor Jukes congratulated Mr. Westropp on the great success with which he had broken ground. Although it was his first paper, it was evidently not his first attempt at field work; and the clear manner in which he had put forward his facts rendered them at once intelligible. He could understand his having been perplexed at the ashy appearance of some of the branching veins which he had described, because he himself had been occasionally perplexed as to whether particular masses of trap were

* "There is another *constant* 'up and down' motion nearly in *all* bogs, consequent upon the least vibration arising either from passing weights shaking the ground, storm, or any *wind* agitating trees or other objects upon the surface. It is always 'up and down;' for, the layers of the peat being horizontal, it is evident that the least disturbance produces motion in a line vertical to the planes of the layers *only*; and, indeed, I believe more of the density of the bottom layers of bogs is due to this constant percussive action driving the moisture to the surface than to the mere superincumbent weight of bog. This motion is easily perceived when driving over a bog road.

"W. Harte, C. E."

ash, or were crystalline rock decomposed. But the fact that the greenstone which he described as running persistently between two beds in the upper part of the mountain split into two or three beds below (a circumstance of which he had not been previously aware) proved that the greenstone was intrusive. The small veins issuing from it were an additional proof to the same effect. Such intrusions were not uncommon. He knew of beds of intrusive greenstone running evenly between other beds for miles of length and breadth, preserving almost the same thickness throughout, and not producing any appreciable alteration in the beds above or below. Mr. Westropp's remark as to the great abundance of traps in the Lower Silurian rocks of that district, and their comparative fewness in the Cambrian rocks, was also deserving of attention. This was the case in some of the Cambrian districts in Wales. When he first surveyed North Wales, in conjunction with Mr. Selwyn—who was now Surveyor of Victoria, in Australia—Mr. Selwyn was obliged, after he had mapped the country, to spend some months in going over the whole ground again, and hammering every suspicious-looking rock, for it was only in that way that crystalline greenstones could be known from green siliceous grits. Any one examining the maps of that country would see minute red lines, indicating the occurrence of narrow veins of greenstone. In the neighbouring districts were Lower Silurian beds, in which there were trap rocks of all kinds in great quantities, and of great thickness. It was clear that the trap in the Lower Silurian must have come up through Cambrian; and therefore it was at first sight odd that there should be so little trap in the Cambrian where that only was exposed to view, and such an immense development of it in the Silurian. But this might be accounted for by the supposition that the trap had passed through channels or pipes of communication, like the basalt which overspread an area of 1200 square miles in the county Antrim, with a thickness of from 400 to 500 feet, and which was believed to have resulted from the boiling up of igneous rocks, in a state of fusion, through narrow dykes. Therefore it was quite possible that, in the county of Wicklow, the traps might have passed through such channels as were described by Mr. Westropp. No matter how much a district was worked, it was impossible to exhaust the facts of it. Bray Head was twice examined by most careful workmen, who yet never saw this bed of greenstone. Mr. Harkness did discover it near the old road, and reported the fact to him (Mr. Jukes), but he did not credit it at first.

Mr. Scott observed that, at the time the railway cutting was being made at Greystones, a trap dyke was met with. He got a small piece of it, and it was of the same crystalline texture as that which Mr. Westropp now produced.

Mr. W. H. Baily, F. G. S., then read his paper, entitled "Some Additions to the Structure of Palæchinus" (p. 65), of which the following is an abstract:—He stated, that, since his last communication to the Society on this subject, he had been enabled to examine an additional specimen of *Palæchinus ellipticus*, which had been presented to the Geological Survey by Mr. Michael George Ryan, who had been fortunate enough to knock out two of these rare fossils from a block of limestone used in the construction of a drain at Bettyville, near Croome, county Limerick. Mr. Baily remarked that this fossil was in the state of a cast; the matrix in which it had been imbedded, having retained the test or shell, had been left behind; and he urged the necessity upon collectors of preserving both sides of a specimen, one of which often served to elucidate particular plates which may have been obscure on the other. He believed this fossil exhibited some additional particulars with regard to the structure of its shell, with which we were not before acquainted. In the first instance he thought there was good evidence of a mouth opposite to the apical disk, corresponding with a similar arrangement of parts in the recent Echini, the parts appearing to have terminated in a slightly reflected edge. The arrangement of the apical disk alone in Palæchinus, corresponding as it does so generally with more recent forms of Echini, would entirely set aside the notion as to their having been provided with stalks like the Crinoids, and in his opinion proved them to have been more nearly related to the free Echinoderms, of which the recent Echinus is a typical example; and he stated that this fine fossil, which we owe to the liberality of Mr. Ryan, assisted very much in confirming him in this opinion, as it appeared to have a distinct oval termination at the opposite pole to that of the apical disk—an arrangement entirely in accordance with its other structural peculiarities.

The last business in the paper was the exhibition, by Captain Hutton and Dr. Frazer, of some specimens of serpentine and other rocks, for examination under the microscope.

Dr. Frazer said that, when Dr. Dawson had announced the discovery of some microscopical fossils, which he had named *Eozoon Canadense*, in the serpentines of the Laurentian period in Canada, the attention of microscopists at this side of the Atlantic was directed to the subject, and Dr. Carpenter had published some drawings of the specimens which he had observed. The remains examined and drawn by Dr. Carpenter verified perfectly all that had been discovered in Canada. Mr. Sandfort, of Somerset, examined specimens of Galway serpentine, in which he found organic traces similar to those exhibited by the Canadian serpentine. Captain Hutton then took up the subject, and worked it out in an excellent manner. He had himself seen veritable Eozoa in the Galway serpentine. As an old microscopist, he would just add that, in looking at the specimens which would be submitted to them by Captain Hutton, they should bear in mind that, in order to effective microscopic observation, a sort of faculty was required, which could only be attained by constant practice.

Professor Jukes asked Dr. Frazer did he think that what was visible in the Connemara marble was identical with what was apparent in the Laurentian serpentine. Because it was by no means certain that the rocks of Connemara were geologically the same as the Laurentian rocks of Canada; on the contrary, he believed the balance of evidence was quite the other way, and that it was almost certain that they were not.

Dr. Frazer said that the microscopic investigation as yet made was vastly too imperfect to warrant any conclusion on that point. They were certain that the three varieties of serpentine now submitted presented organic traces, and also that between these traces there was a resemblance. They had examined serpentines from many other localities, and had found nothing of the kind in them, while these varieties were in other respects homogeneous. But the organic traces contained in the first three indicated that, so far, they were not homogeneous rocks. As to the specific details of difference in the organic remains, these were yet to be discovered. It being suggested to him to say something as to the nature of the extinct animals evidenced by the fossil, it was thought by Sir William Logan that these were all gelatinous, amorphous creatures, and that they once attained an immense size.

Mr. Harte read the following passage from a letter written by Sir William Logan, the Director of the Canadian Survey, who had kindly sent him a specimen of the original rock, which had been examined by Dr. Dawson:—"In etching the specimen with muriatic acid for the purpose of bringing to view the casts of the tubes in the minute structure, a very dilute acid should be used. Too violent an action may break off the casts. I have marked the part where I think you will get the best evidence of the minute structure with a ring of ink. The green layers in the specimen replace the sarcode of the animal, and consist of very fine serpentine; the white layers are carbonate of lime, and constitute the shell or skeleton, with the exception of the lowest white layer, which is white pyroxene, on which the animal began to build. In it, however, there are occasional small patches of carbonate of lime, and in some of these the minute structure has now and then been observed. The pyroxene may possibly be a more ancient structure by the same description of animal, in which the evidence of organization has been nearly obliterated by chemical action and crystalline forces. If you have anything of the same sort in your neighbourhood, it will most probably be found where there is some band of limestone associated with a little serpentine, or some other silicate of magnesia or of lime."

Mr. Baily doubted that the thing in question was a fossil at all. He had seen in serpentines cellular structures that might easily be mistaken by enthusiastic persons for Foraminifera. As to gelatinous bodies being preserved as fossils, he did not believe it at all. The supposed fossil in the green Connemara marble was now said to be a distinct species from that found in Canada, and he would be glad to know the evidence on which this had been based.

Captain Hutton asked Mr. Baily to name the serpentines in which he had seen cellular structures. He had examined upwards of a dozen specimens from Canada, Donegal, Connemara, and other localities; and the specimens from the three localities named were quite different from all the others.

The meeting was then adjourned, and the gentlemen present spent some time in the examination of the specimens submitted to their inspection.

May 10, 1865.

Gilbert Sanders, Esq., in the Chair.

The minutes of the last meeting were read, compared, and signed. Donations were announced, and thanks voted.

Mr. Jukes read his paper—"Notes for a Comparison between the Rocks of the South-West of Ireland, those of North Devon, and of Rhenish Prussia, in the neighbourhood of Coblentz" (p. 105).

Professor Haughton expressed his entire concordance with that part of Mr. Jukes' paper which did away with the Devonian system as a separate formation, and showed that the three subdivisions of the strata in the South of Ireland—viz., the Carboniferous Limestone, Carboniferous Slate, and the Coomhola Grits—are contemporaneous with each other. The view that the rocks in the South of Ireland were not Devonian, and therefore different from those found in other parts of the island, was that which had been maintained for many years by Irish geologists. Formerly, when this question had been under discussion at the meetings of this Society, Irish geologists had been told to wait for the decision of palæontologists as to the nature of the fossils found in Cork. That opinion had been given, and it was to the effect that the views which had been so long maintained in Ireland were correct. He had himself examined the rocks of Devonshire and of Rhenish Prussia, and had been quite unable to make out Professor Sedgwick's system there at all; but still he did not mean to say that Professor Sedgwick's system had no existence. It was well known to every one who had ever paid any attention to the science that Professor Sedgwick was one of the most painstaking of field workers, but still his views might not bear so extended an application as had been given to them. He would wish, in conclusion, to ask Mr. Jukes if he now formally gave up the name Devonian as a term for a separate formation?

Mr. W. H. Baily stated that he quite agreed with Mr. Jukes as to the general identity of the species of fossils from the Carboniferous Slate with those of the Carboniferous Limestone, and to the great similarity between the Carboniferous Slate fossils of the South of Ireland with those of North Devon—a resemblance which had been noticed by Mr. Godwin Austen as long ago as 1840, in his paper in the Geological Society's Transactions, on the "Geology of the South-East of Devonshire." Mr. Baily remarked that he would exclude from this resemblance to the Carboniferous fossils the limestones of Plymouth, Newton Bushell, &c., of which as yet no representatives had been discovered in Ireland, although on the Continent similar fossils were described from Nassau, in the fine works of the Drs. Sandberger. He observed that these limestones of South Devon contained a set of fossils in beautiful preservation, amongst which were genera and species peculiar to them, such as Calceola, Stringocephalus, Bronteus, &c., the corals, shells, and crustacea resembling more a Silurian than Carboniferous type, forming such an assemblage as would, he thought, entitle them to be considered as passage or transition beds from the Silurian to the Carboniferous, and for which the term Devonian might be conveniently retained, independently of the Old Red Sandstone, which contained an entirely different set of fossils—principally fish remains—a representative of which occurs in Ireland, at Kiltorcan, in the county of Kilkenny, and probably some localities in the county of Cork.

Mr. Jukes, in reply, stated that he had always maintained the Coomhola Grits were a part of the Carboniferous Slate, and not a special series, though at Bantry Bay they attain a thickness of 2000 or 3000 feet. There are at the same time in them certain characteristic fossil forms, such as Curtonotus and Cucullœa. He did not think that this paper could fairly be called a recantation of former opinions, as he did not think he had ever expressed views materially different from what he brought forward now. At all events, he was always ready to give up an opinion, if it was clearly shown to be wrong. As to the section which he exhibited, he did not know that any Irish geologist had ever put forward the view advocated in it. Sir R. Griffith makes the Carboniferous

Limestone above the Slate, not contemporaneous with it. In answer to Professor Haughton's question, he would say that he did not wish to jump to the conclusion that there is no Devonian formation at all. No one was more ready than he (Mr. Jukes) to throw off authority when it was not supported by evidence derived from hard work; but in the case of his own old teacher in the science (Professor Sedgwick), and his present chief (Sir R. Murchison), there were few men living who had gone through more hard work, hammer in hand, in the various districts which they had explored.

Mr. Scott, on behalf of Dr. Carte, exhibited a specimen of an antler of a Megaceros, which showed the impression of a cannon bone on the palm, and also two lower jaws of the same animal, which had rubbed each other. These specimens came from the county Limerick, near the locality whence the indented bones recently exhibited by him had been procured, and had been brought up by Mr. Hinchy, the finder of the former specimens. Those now exhibited afforded additional confirmation of the opinion that these markings resulted from the fortuitous juxtaposition of the bones in the marl, and were not the result of human agency.

Mr. Hinchy, on being called upon by the Chairman, gave some explanation of the position in which the bones had been found.

The meeting was then adjourned.

June 14, 1865.

Captain Meadows Taylor, M. R. I. A., in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

The ballot for the election of new Fellows was declared open. Messrs. Reeves and Macalister were appointed scrutineers.

Mr. Scott, one of the Honorary Secretaries, announced that the part of the Society's "Journal" for 1864, being Part I., Vol. I., of the "Journal of the Royal Geological Society of Ireland," was now ready for distribution to all Fellows whose subscriptions for 1865 were paid. He also announced that the Catalogue of the Society's library was now in type, and would be ready for distribution before the end of the month. It had been decided by Council that the Catalogue should not be given to the Fellows, but should be sold at the price of one shilling per copy. Any Fellow who wished to have a copy forwarded to him with his copy of the "Journal" was requested to forward one shilling in stamps to the Assistant Secretary for the purpose. It was hoped that this Catalogue would render the library of greater value than before.

Mr. Brownrigg read a paper—"Notes on Part of the Leinster Coal Field, with a Record of some Fossils found therein" (p. 145).

Professor Jukes observed that the communication of Mr. Brownrigg was a very important one, and they were very much indebted to him for rescuing the remains in question from destruction. He (Professor Jukes) was unable to say anything more than Mr. Brownrigg had already said. He was equally in the dark with him as to the nature of the fossils, and he came there in the hope that Mr. Brownrigg had discovered the key to them. Whether the impression on the large slab was a fish or a reptile, he would not undertake to say. He had expected that an opinion would have been offered upon it by some of the comparative anatomists of Dublin. He sent a photograph of the smaller impression to Professor Huxley, who had replied that he could not give an opinion from a photograph, further than that what seemed to be the bones were rather too thick and strong for a fish, and rather indicated reptilian affinities. The impression like an eel was very singular. The existence of anything like an eel in so very early a rock as the Coal-measures would be unexampled, as the Teleostea did not come into existence until the Chalk period. It would be still more strange if it turned out to be a snake, as there were no other records of snakes in those early rocks either, and yet the impression resembled an eel or snake more than anything else. He trusted that Mr. Brownrigg would be able to give them further information on a future occasion; still they were very much indebted to him for what he had done.

Dr. Macalister observed, that these were amongst the most interesting palæontological remains that he had ever seen. He believed it would be very difficult for any comparative anatomist to give an opinion upon them. With regard to the other specimens, the joints in them were not like those of any vertebrate animal that he ever saw. They seemed to have something of the plesiosaural nature; but, unless other specimens should be discovered, he thought it would be impossible to determine their species.

Mr. Brownrigg said he felt that, with his present information, it would have been premature to attempt anything more than he had done.

Mr. Bolton observed, that there was a remarkable specimen of a young Ichthyosaurus in the Museum of Trinity College, the caudal vertebræ of which had no appendages whatever, so that it appeared to be the remains of a reptile in a tadpole state. Therefore the want of appendages in the fossils produced by Mr. Brownrigg did not infer that they were not reptilian.

Mr. Brownrigg said, with regard to what was like an eel, that the miners told him the fossil was originally four feet long, but had been broken.

The Chairman said he was sure the meeting were highly gratified by the specimens Mr. Brownrigg had exhibited; and he had no doubt that they could look with confidence to his exertions in not only making future investigations, but also in rescuing every specimen that could possibly be found in these Coal-measures from destruction or oblivion.

Mr. Scott then read a communication from Mr. J. B. Doyle, "On the Occurrence of Jaspery Clay at Fair Head:"—

"In walking from the *Grey Man's Path*, Fair Head, towards the shore, on my way to Ballycastle, April 29th, I came along the north shore of Lough Crannagh, across some rounded masses of basalt, which dip into the lake at a low angle. Having been on the hunt for ironstone, and my eye sharp for its occurrence, I was struck with an unusual appearance in the flat masses of rock over which I was walking. I saw at a glance that it was not *basalt;* and as there was (as I supposed) no other rock formation in that district, I concluded that what I had observed must be a bed of hæmatite. I accordingly retraced my steps, and broke off several pieces with my stick. I found it quite easy to procure specimens, from its brittle nature; and, upon examining the fractured surface, I found it of a fine texture and of a bluish tint—very like a stone that I saw at Magilligan, county Derry, thirty years ago, which Mr. Graham, the Rector, called *Lydian Stone.* To my surprise, most of the specimens, when struck with my knife, threw out abundance of sparks like a flint. I then thought it must be a cherty rock; yet I could not account for its occurrence just there.

"I have numbered all the specimens from this place 1.

"About a fortnight after this, in company with a miner, while searching for an iron band in the face of the Ballyreagh Cliffs, on approaching the boundary of the townland of Ballyrey, where Mr. Mac Gildowney is working an ironband seam, a little to the east of the dyke that occurs between the Gob and Griffin Collieries, I perceived, immediately under the basaltic cliff which rests upon the freestone at this place, a pale bluish-looking stone, which upon examination proved to be the same as that found at Lough Crannagh, only more brittle, softer, and much lighter in colour. On closer examination I found that it became harder and more ferruginous as it approached the basalt, until it seemed to mingle with it. I send two specimens from this point, numbered 2, 3—the latter having very much the character of our clayband ironstone. As none of the miners had observed it before, I was induced to write to you on the subject. I took it to be fire clay indurated by the basaltic rock above it, from the fact of there being several seams of fire clay in the cliffs in connexion with the coal and ironstone; but I was so puzzled at the occurrence of the same stone at Lough Crannagh, lying amidst the basaltic rocks, that I became uncertain until I had your opinion.

"I subjoin a trace showing the situation of the two places, also a small section of the cliff where Nos. 2, 3 were found.

"I may add that I discovered a very pure band of the blackband ironstone, marked A, which had not been known to exist in that situation previously."

Mr. Scott called attention to a structural peculiarity in some coal which he had received about a year ago from Vancouver's Island. It consisted of small radiating plates, like fishes' scales, lying in parallel planes, and disseminated through the coal.

Mr. Clibborn, of the Royal Irish Academy, had since called his attention to specimens of amber in the collection of the Academy, which exhibited a very similar peculiarity. He wished to know whether any gentleman had ever noticed anything of the same nature either in coal or amber. It appeared to him to indicate something like the drying up of bituminous matter in the interior of the substance, as in the amber there were cracks wherever the edges of the scales reached the surface. The specimens of amber in the Academy's Museum which exhibited this structure were all wrought amber, which had been dug up in bogs, where they had lain for a considerable time; and he (Mr. Scott) was disposed to attribute the production of the scales to a chemical action which had set in while the amber was buried in the earth.

The Scrutineers reported the result of the ballot, and the Chairman announced that the following gentlemen were elected Fellows of the Society:—G. H. Morton, Esq., Hon. Secretary, Geological Society, Liverpool, Lecturer on Geology, Queeen's College, Liverpool, 7, London-road, Liverpool; G. Ollis, Esq., Royal Engineers' Department, Royal Barracks; John Radley, Esq., Monte Video House, Bray.

The meeting was then adjourned till November.

NOVEMBER 8, 1865.

R. CALLWELL, ESQ., in the Chair.

The minutes of last meeting were read, compared, and signed; donations were announced, and thanks voted.

H. P. Wall, Esq., was elected an Associate of the Society for the Session 1865–66.

The Rev. S. Haughton, M. D., read the following notice of the "Fall of a Meteorite," on the 12th of August, at Clonoulty, near Cashel:—

"John Johnson, of the parish of Clonoulty, near Cashel, was walking across his potato garden, at the back of his house, in company with Michael Fahey and William Furlong, on the 12th of August, 1865, at seven P. M., when he heard a clap like the shot out of a cannon, very quick, and not like thunder. This was followed by a buzzing noise, which continued for about a quarter of an hour, when it came over their heads, and on looking up he saw an object falling down in a slanting direction. They were frightened at its speed, which was so great, that they scarcely could notice it; but after it fell, they proceeded to look for it, and found it at a distance of forty yards, half buried in the ground, where it had struck the top of a potato drill. They were a long time looking for it, a longer time than that during which they had heard the noise. On taking up the stone, he found it warm—milk warm, but not hot enough to be inconvenient. The next day, it was given up to Lord Hawarden, who has presented it, on certain conditions, to the Museum of the University."

Professor Haughton said that, at Lord Hawarden's request, the results of the examination of the stone would be laid before the Royal Irish Academy when completed, but he wished to secure the priority of publishing the notice to this Society.

Mr. H. P. Wall then read a paper, "On some Fossils from the Neighbourhood of Castlecomer:"—

"These fossils, which were obtained from the Jarrow pit, have been submitted by me to the opinions of Lord Enniskillen, Dr. Carte, Mr. Baily, and others; and I am accordingly enabled to give the following sketch of the probable affinities of some of the specimens:—

"I. Is a very fine specimen of the well-known Coal-measure genus, Megalichthys, probably *M. Hibberti*, of which species a figure is given in Agassiz 'Poissons Fossiles,' tom. ii., Plate 63, *et sqq.* He only figures detached segments, but here we have nearly the whole fish. The impression measures 16 inches in length to the point of insertion of the tail, and 4½ inches in width at the point of attachment of the ventral fin. The specimen is a cast, showing the under surface of the head, with the row of small teeth in the upper maxillary bone, left side, well exhibited. The lower maxillary bone on the same side is also well preserved, and exhibits a distinct row of minute punctures along its interior edge. The right inferior maxillary is also seen, and in parts we can trace the corresponding row of punctures in it, although the bone is fractured.

"The scales, many of which are preserved, exhibit the delicate granulations characteristic of the genus, and some of them show the longitudinal slit, which, if the scales

were in their normal position, would probably indicate the situation of the lateral line. The specimen appears to be twisted, and we see on one side the mutilated remains of two fins, which I am disposed to consider the ventral and anal fins; there is no trace of a dorsal fin; and the portions of the tail which are preserved, are a number of small spines. The surface of the bones of the head is covered with minute granulations; and in one place, where a fracture exhibits the inner side of a portion of the superior surface of the head, we find the plates to be very smooth, with the exception of a few well-marked tubercles.

"In front of the ventral fin we have a very remarkable impression, exhibiting a semicircular outline, with irregular diverging radii (? pectoral fin).

"II. Is a cast of the upper portion of a smaller specimen of the Megalichthys, the surface of which exhibits the markings before referred to as noticeable on the interior of the plates of the upper side of the head of the last specimen. We see on the same specimen some detached segments—one with a serrated edge, perhaps the jaw with its teeth; and also some scales, with the same granulations as on the large specimen. There is also a confused mass of scales of Megalichthys, showing the fins.

"III. Is a specimen which I am informed is quite new; it exhibits the curved vertical column, with ribs attached, of an animal which Mr. Baily and Dr. Carte consider to be a fish resembling an eel. It is sixteen inches in length, and preserves its breadth nearly uniform throughout. The ribs are inserted into the transverse processes at a very acute angle; there are also in places indications of a wrinkled skin running along the whole body.

"IV. Is a specimen presented by the Rev. J. M. Emerson; it exhibits a part of the vertebral column and ribs, with a cast of the head of a small eel-like fish (?); in the cast of the head a number of minute teeth may be seen. In this specimen, too, the skin has been preserved in the form of a few very delicate impressions, of fine rays; these are only perceptible when viewed by a very strong light. The ribs, where best seen, are short and straight, and pointed backwards.

"V., VI., and VII. are separate fragments, which are supposed by Mr. Baily to belong probably to Archegosaurus, the well-known reptile of the Coal-measures of Germany.

"V. Presented by Mr. Edge, exhibits a confused series of vertebræ, with some scattered spines. We see also preserved portion of the three plates which would apparently be those which occur on the under surface of the body between head and trunk. One of these, resembling in shape the "elytron" of a beetle, is that which is best seen. Portions of this fossil are still concealed in the stone.

"VI. A faint impression of a head.

"VII. Some detached segments, which may be perhaps isolated ribs of the same animal.

"VIII. Presented by Mrs. Bradley, is a confused series of small vertebræ and ribs. The vertebræ resemble those which were exhibited by Mr. Brownrigg at the June meeting; they lie in every position, so that their structure can be well perceived."

Mr. W. H. Baily remarked upon the great interest which attached to the fossils from the Jarrow Colliery, brought before the notice of the Society at a former meeting by Mr. W. B. Brownrigg, and those exhibited on the present occasion by Mr. H. P. Wall and others; he considered the peculiar reptilean remains in this collection to correspond very much with those described by Hermann Von Meyer, as occurring in the Coal formation of Saarbrück, between Strasburg and Trèves.

Mr. Baily observed that, in the specimens submitted to his examination by Mr. Brownrigg, he detected scales of the large predaceous sauroid fish *Holoptychius Portlocki* and *Megalichthys Hibberti*, with defence spines of *Gyracanthus formosus*, or *tuberculatus*, a species he had before noticed in Mr. Edge's collection of fossils from the same colliery. The fine specimen of *Megalichthys Hibberti* exhibited and presented by Mr. Wall was almost entire, and confirmed his former identification of this species from the scales alone.

The majority of the fossils appeared to him to be those of air-breathing reptiles of the Sauro-batrachian type, some of them resembling Archegosaurus, one of the Labyrinthodonts; one of the fossils presented by Mr. John Edge corresponding very closely with the fine figures of that remarkable lizard given in Dunker and Meyer's "Palæontographica."

Mr. Baily also alluded to a very perfect specimen of a fossil lizard, obtained by Mr. C. Galvan, of the Geological Survey, from the same colliery, which he considered to be related to the Tritons, or Salamanders, and which he hoped to be enabled to exhibit at the next meeting; he considered great praise was due to Mr. Brownrigg, who had first brought these interesting fossils before the notice of the Society; also to Mr. Wall, for the additional specimens he had produced.

Mr. Brownrigg and Professor Haughton offered some observations, and the meeting then adjourned.

DECEMBER 13, 1865.

ALEXANDER CARTE, Esq., M.D., in the Chair.

The minutes of last meeting were read, compared, and signed; donations were announced, and thanks voted.

The following gentlemen were proposed by Mr. Ormsby, and seconded by Dr. Macalister, as Associates of the Society for the year 1865-66:—John Petherick, 29, T.C.D.; R. M. Cotton, 24, T.C.D.; George Bayley, 12, T.C.D.; James Reed, 19, Corrig-avenue, Kingstown; Howard Grubb, 141, Leinster-road, Rathmines; Charles Faris, 34, Leeson-street; Charles R. Thorp, 39, Kildare-street; Charles Waring, 11, T.C.D.; Fergus Smith, 71, Lower Baggot-street; George Babington, 29, T.C.D.; and elected unanimously.

Mr. Jukes then read his paper, "Further Notes on the Classification of the Rocks of North Devon" (p. 138).

Professor Haughton read his "Observations on the Glaciers of Norway, as compared with those of Switzerland."

"The Glacier of Bondhuus, or Mureinger Braen, is the largest of the icefalls that flow from the Folgefonden, or great icefield of Western Norway. Its length (that of the glacier) is about one mile, in which space it falls perpendicularly about 3000 feet, and it is everywhere so crevassed as to render its exploration impossible.

"It has a double curvature in its descent, and at one of the curves there is a continued succession of avalanches, while at the other there is a dangerous "stonefall," probably caused by the pressure of the ice against the rock.

"The foot of the glacier is 1093 feet above the Mureinger Fiord, or sea level; but it formerly occupied a position only 40 or 50 feet above that level, and has retreated up the valley from time to time, leaving behind it *four* ancient moraines, that mark its successive positions.

"The third of these, reckoned from below upwards, extends across the valley, and forms a large lake, which has to be crossed in a boat in order to reach the Glacier. (The lake is 630 feet above the sea level.)

"At the entrance of the Mureinger Fiord we noticed four ancient sea beaches, indicating the former level of the sea at different periods.

"Can it be possible that the elevation of temperature which caused the foot of the Glacier to retreat four times in succession was caused by this change of sea level, which was also repeated *four* times?

"From 3° to 4° Fahr. difference of annual temperature would be sufficient to account for the movement of the foot of the Glacier; and this might be produced by the emersion of the land from the sea. I could trace with intense interest its course from the great icefield, through a curve in the mountains, down to a point nearly 3000 feet lower, where it terminated. The waves of ice looked like the wildest waves of the sea. . . . The water, which was caused by the melting of the snow and ice, formed a considerable river; its waters were almost ice cold."

Mr. Jukes and Mr. Close made some observations.

Mr. Baily exhibited a drawing of a Fossil, "Keraterpeton Galvani," alluded to by him in the course of the last meeting.

The meeting then adjourned.

January 10, 1866.

A. Carte, M.D., V.P., in the Chair.

The minutes of last meeting were read, compared, and signed; donations announced, and thanks voted.

The Secretary read a paper by J. H. Kinahan—"Notes on the Foliation in the Gneiss and Schist of Yar Connaught" (p. 147).

Mr. J. Scott Moore presented a remarkable specimen of a Boulder of Granite from Kilbride, county Wicklow, which exhibited a series of concentric bands of agate, enveloping crystalline quartz.

The meeting then adjourned.

Anniversary Meeting, February 7, 1866.

J. Beete Jukes, Esq., F. R. S., in the chair.

Minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

The ballot for officers and council for the ensuing year, and also that for election to the Fellowship of the Society, were declared open.

R. Callwell, Esq., and A. Carte, Esq., M. D., were appointed as scrutineers of the ballot for officers and council; and C. P. Cotton, Esq., and E. H. Bennett, Esq., scrutineers of that for the election to the fellowship.

The Chairman called on Mr. Scott, one of the Hon. Secretaries, to read the annual report, with the appendices (p. 158).

Mr. Scott then read Mr. Harte's paper "On the Occurrence of Kjökkenmöddings in the Co. Donegal" (p. 154).

The Chairman said he need not ask them to return thanks to the author of the paper; for, by the acclamation with which they had greeted the conclusion of his paper, he perceived that they had already done so. Nevertheless, as a matter of form, he would again ask them to return thanks to him. The department of science within which the paper fell was not one to which he himself felt any particular attachment. There was one little circumstance which he would like to mention. It was not the first time that these shell mounds had been noticed in these countries. The existence of kitchen middens in Ireland had been already spoken of by one of the Officers of the Survey, Mr. George H. Kinahan, who two or three years ago wrote a letter to the "Reader," announcing the existence of shell mounds between Galway and Oranmore. But they were not the less indebted to Mr. Harte for the complete account which he had given of what he had found in Donegal. Some years ago Mr. Jukes had himself observed on the south side of Kenmare Bay, by the side of a newly-cut road, a great heap of oyster shells, about thirty yards long by about five feet thick, precisely similar to the heaps which had been described. At first he thought it might be a raised beach; but on his return he examined it again, and saw that it could not be a raised beach, as many of the shells had their valves open, and in such a state that, if the land had gradually risen, or had ever stood between high and low water, the washing of the tide must have cleared them all away. Therefore it could not have been a raised beach in the ordinary sense of the term, unless they could have imagined it jumped up at one tide. The late Dr. Ball told him that at the end of the last and the beginning of this century, oysters without their shells were brought preserved in kegs from Kenmare to Youghal; and he therefore concluded that this heap of oyster shells was one of the relics of that operation; but when looking at the mound, he was struck with their ancient, decayed appearance. Therefore it occurred to him now that it might be a shell mound left by the very early inhabitants—a record of their old feasts. At the present day, in Australia, there are great mounds of shells along the sea coast, which have been left by the black fellows who come down every year to live

for some months on oysters; and he had no doubt that in these shell mounds might be found implements exactly similar to those under discussion. They would not be so perfect, however, as no Australian black ever gave himself the trouble of polishing the piece of stone of which the hammer that he usually carried was composed. It was clear that the implements found by Mr. Harte must have been artificially made; and they were, moveover, a proof that very considerable commerce must have gone on in those times, as the flints with which they were made did not exist in Donegal, nor nearer than Antrim. The natives of Port Essington, on the northern coast of Australia, used a quartzite for their spear points, which was not found within several miles of that place. It was an interesting fact that we should have occurring in Ireland accumulations precisely similar to those which had been noticed on Scandinavian coasts and in other parts of the world.

Mr. Scott said, he had been informed by a friend who was engaged in the relief works in the South of Ireland, that on making a road on the sea shore at Kenmare they cut through heaps of shells containing those flint stones, and any one who went down there now would find them.

Mr. Joseph Scott Moore remarked that in Donegal and Londonderry the word "midden" was applied to a dung heap.

Colonel Meadows Taylor said, he had seen specimens of split flints, discovered under similar circumstances in the interior of India. An officer who was employed in sinking foundations for a building told him that he found in the same way a number of flints, jaspers, and agates. He had been thinking of preparing a paper on the subject, and sending specimens of the flint implements which had been found in India.

The Chairman mentioned that a paper describing flint implements had come from the Geographical Survey of India.

Mr. Donovan begged to mention, as an archæologist, and not a geologist, that five or six heaps of this sort, which had been found in Ireland, were described in the Transactions of the Kilkenny Archæological Society. One of these was discovered on the coast at Bannow Bay, and two or three on the coast of Wexford. In these were found some bones of the old *Bos longifrons*, but much fewer marine animals than were usually found on the coast. A large one was found at Dunshaughlin, from which an enormous number of things had been brought to the Museum of the Royal Irish Academy. He was not aware that these mounds had been searched with the same degree of care as had been practised since the bone and cave discoveries in France and elsewhere. Two or three had been found in Kilkenny; but there were several in different parts of the country; and it would be a most excellent thing if all were carefully searched by the different archæological societies within whose districts they were included.

Mr. Scott said, it would be very hard indeed to procure perfect accounts of the contents of these heaps. The Danish shell mounds, which extended for several hundreds of yards, were worth so much a ton as manure; and it had been usual only to examine sections of them.

Mr. Donovan observed, that a heap of the kind in question was found near Skerries, in which a friend of his observed an immense quantity of things, including some heads of the *Bos longifrons*. He got the heads, and presented them to the Royal Irish Academy. Several hundred heads were found, and also quantities of pigs' and sheep's heads. He was not aware of any heap in Ireland being of a greater length than thirty yards. The one on Bannow Bay was only eighteen inches deep, and had been excavated all through.

Mr. Jennings remarked, that it had been asserted that there had been a rise of the land about the great wall of the Picts. If so, the Kjökkenmöddings ought to have been raised up, and consequently it would be interesting to see at what distance they now stood from the seaside in localities where recent alteration of level had taken place, as in Scandinavia.

Mr. Scott said, he did not believe the records of any Kjökkenmöddings having been found in places where an alteration of the level had been proved to have taken place. They were most abundant in the Danish Islands, and in Caithness; they were also common on the coast of Labrador.

The scrutineers presented the reports of the several ballots, and it appeared that the following Fellows had been elected officers and council (see list, p. 165); and the following gentlemen had been elected Fellows:—

Samuel Bradley, Esq., Little Castle, Castlecomer; Daniel B. Edgeworth, Esq., Kildare-street Club; Arthur W. Foot, M. D., 21, Lower Pembroke-street; Samuel P. Graves, M.P., Liverpool; William Harold, Esq., Mining Co. of Ireland, Ormond-quay; R. Heron, Esq., Mining Co. of Ireland, Ormond-quay; W. H. Knapp, C. E., 6, Belgrave-square, Monkstown; John J. Lalor, Esq., 2, Longford-terrace, Monkstown; A. M'Clintock, M. D., 21, Merrion-square, North; H. Stewart, M. D., Lucan.

The meeting then adjourned.

XXVI.—NOTES ON SOME OF THE DRIFT IN IRELAND. By G. HENRY KINAHAN, F. R. G. S. I., Senior Geologist of the Geological Survey of Ireland.

[Read March 14, 1866.]

CONNECTED with the drift in Ireland, I have observed various phenomena, to which I intend in the first place to call the attention of the Society, and afterwards to offer some suggestions as to the agencies by which they may have been produced.

First. The principal features of the hills and mountains would seem to have been formed in a great measure previous to the drift period; as in most of the valleys more or less boulder drift occurs, which usually rests upon "ice-dressed" rocks.

These præ-drift-formed features can be well observed in the mountains about Lough Mask, counties of Mayo and Galway. On looking at these eminences from some distance on the south, it will be seen that those on the north of the lake slope gradually down to the plain on the east; and that on the south of the lake, if a line be stretched from the mountains west of Toormakeedy (Slieve Partry) to the country east of Cong, this line would rest on the slightly-sloping table top of Benlevy,* the isolated mountain between Loughs Mask and Cong; and also that it would coincide with the previously mentioned slope on the north of Lough Mask.†

On an inspection of these hills, it will be found that the floors of the valleys are "ice-dressed," and that many of the valleys contain boulder drift. From this it may be inferred that at one time these mountains stretched in a gradual slope from Slieve Partry to Partry on the N. E., and to beyond Cong on the S. W.; that, after this, the area now occupied by Lough Mask and its tributary valleys, also the valleys between Slieve Partry and Benlevy, and the undulating ground between Benlevy and Cong, were denuded away, and that subsequently the rocks were "ice-dressed," and the boulder drift deposited in the valleys.

Very similar results can be observed in respect to the hills in Slieve Aughta, the mountain group lying at the junction of the counties of Galway and Clare. Looking at them also from the south, it will be observed that the flats on the table-topped hills, east and west of Lough Graney, if connected, would form a continuous upland; and, moreover, they are capped with nearly horizontal basal beds of the Old Red Sandstone group. Now, these hills are separated by valleys in which boulder drift occurs, lying on the "ice-dressed" rocks.‡

Second. Præglacial drift. Seemingly before the boulder drift

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* *Gable Hill;* so called from its likeness to the gable of a house.

† From Derradda, the hill S. W. of Oughterard, county of Galway, there is a good panoramic view of all the Yar-Connaught and Connemara hills, from which it would appear that they once formed one great slightly undulating table land.

‡ See "Mems. Geological Survey, Ireland," Ex. Sheets 115 and 116, p. 28.

period there was a drift that in places contains the remains of trees and plants. This drift has been found in the Bolleyneendorrish River valley, which lies eastward of Gort, county of Galway,* and on the Castlecomer table land, the mountainous district that lies at the junction of the Queen's County, Kilkenny, and Carlow.† Mr. Wilkinson also seems to have recorded præglacial drift at Nenagh, county of Tipperary, as there a black peaty bed was found, under "forty-three feet of hard calcareous clay, with numerous lumps of limestone intermixed, but unstratified." ‡

Third. Ice-dressed Rocks. With reference to the class of phenomena now entered on, I have observed that there are two distinct sets of striæ, or scratches. The oldest one, which for convenience sake in these notes will be called the *Primary*, as its striæ correspond with the long axis of the "crag and tail," and of the principal "Tors,"§ or ice-dressed hummocks of rock, has a general bearing of about N. N. E. or N. E., to the S. S.W. or S.W.; and the "crags" and "Tors" are precipitous, or *crag* towards the southward, and slope or *tail* towards the northward. The general bearing of the "crag and tail," the *Primary* "Tors," and the *Primary* striæ is slightly modified while crossing mountains and high ground, having westings or eastings respectively when the slope of the mountain or high ground is eastward or westward.

The Primary set of striæ is crossed at various angles by another set, which may be called *Secondary*, and always coincides with the direction or general fall of the valleys in which it occurs. The *Primary* striæ are very often quite obliterated by those belonging to the *Secondary* set; and often the *Primary* "Tors" are modified by the *Secondary* ice. One side of the "Tors" may have been planed away by the latter, or one corner of the original crag of the "Tors" cut off, giving them a one-sided appearance. The *Secondary* set may run in any direction across the *Primary* "Tors," but it rarely coincides with their axis, except where such axis agrees with the direction or general fall of the valley.

As every valley has striæ belonging to the *Secondary* set, and as most valleys have smaller ones opening into them, it follows, that at the junction of a main valley with its tributary there may be two sets, viz., the striæ of the main valley and the striæ of the tributary;

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* See "Mems. Geol. Survey, Ireland," Ex. Sheets, 115 and 116, p. 28.

† See "Mems. Geol. Survey, Ireland," Ex. Sheet 137; and paper by Author, "Geological Magazine," Oct., 1865.

In a Paper read before the Society, May 13th, 1846, "Note on the Tertiary Deposits of the County of Wexford," the author, Captain James, R. E. (now Sir H. James), mentions seventy-four species of fossil shells, some of which are Arctic, that were found in what he seems to consider præglacial drift. (See "Journal of the Geological Society, Dublin," vol. iii., p. 195.)

‡ See paper by T. Oldham, M. R. I. A., "Journal of the Geological Society of Dublin," vol. iii., p. 64.

§ This English name for the dressed hummocks of rocks has been copied from "Frost and Fire," by J. W. Campbell, as it is more concise than the Continental term, *Roches Moutonnèes.*

or there may even be three, as the *Primary* set in this place may not be completely obliterated; and then in this case, besides the Secondary striæ just mentioned, the Primary striæ would also occur.

Fourth. Boulder drift.—This deposit is principally made up of fragments and boulders of the subjacent rocks; but in many cases foreign erratics have also been detected, such as nearly always belong to rocks in the country lying north-eastward.* In some places, however, isolated patches of a foreign drift may be observed with scarcely a fragment of the subjacent rocks in it; but often in this case the foreign drift will be found to be overlaid by local boulder drift.

It has been observed that in many of the wide valleys, and on parts of the central plain of Ireland, much of the boulder drift occurs in *esker-like mounds*, which have a rude parallelism to one another, and that often associated with them are striæ that have a bearing similar to the parallelism of the mounds.

Fifth. Post-drift gravels, or esker-drift.—In places on the low country the boulder drift is washed into gravels and sands, which are sometimes spread over the ground, but are more often piled up in long ridges (*Eskers*), or continuous systems of mounds and duns.

These eskers, while crossing high ground, or ending on a mountain slope, break into gravel mounds and short ridges that run in various directions, and among them are small mounds of boulder and *rocky drift*,† against which the esker drift is often piled. For these parts of the esker drift, I have in a paper read some time since before the Society, suggested the name of *Shoal Esker*.‡

Near the foot of some of the mountain slopes there are banks or shelves consisting of boulder drift, rocky drift, and gravels; and connected with these banks are occasionally to be seen irregular ridges, which run with the outlines of the hills, receding from them if the mountain slopes are gentle, and approaching quite close or disappearing altogether if the slopes are steep, or if cliffs are present.

Sixth. Erratic blocks.—Sometimes on the boulder drift, at other times on the esker drift, are found large and small erratic blocks which may be north, south, east, or west of their parent rocks.

Seventh. More recent deposits.—Overlying the boulder and esker drifts are deposits consisting of peat (*bogs*) alluvium (*corcases* and *callows*), shell marls, brick clays, sands, &c.; none of these will be again mentioned in these Notes.

The task now before me is to try to account for these different phenomena by natural causes. The first questions I propose to examine

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* In a few localities—as, for instance, the south part of the county of Mayo—the Boulder drift has evidently come from the southward. The explanation of this will be given hereafter.

† Rocky drift is a term used for a peculiar drift, which consists of large and small angular, subangular, and round blocks of rock, mixed with a little clay or gravelly clay; in some places it seems to be half-washed boulder drift, but when found at high levels in the hills it has the appearance of being the *debris* left after the melting of the glaciers.

‡ See "Dublin Quarterly Journal of Science," vol. iv., p. 109.

into are, whether the country was covered by a large ice field; or an arctic current with icebergs, flowed over it. As the former is the older theory, it shall be considered first.

Land Field Ice.—Previously to the boulder drift period, as the land was gradually rising, the outlines of the present features of the country were carved out by marine denudation; and, when the land had risen high enough, that the climate must have been somewhat similar to what we now have in Ireland, would seem to be proved by the vegetable remains which have been found in the præglacial drift. As the land rose, the climate gradually became colder, glaciers began to form, and the ice finished the work that the denuding power of water had begun. This latter would seem evident, as in the valleys and *Cooms** is found boulder drift reposing on "dressed" and striated rocks. The ice should increase more and more as the climate became colder, until eventually the country was covered with a field of ice, which was at least 2200 feet thick.†

The field of ice would seem to have had a general movement from N. N. E. or N. E. to the S. S. W. or S. W. by which the "Crag and Tail," the primary "Tors" and the primary striæ were formed. This ice sheet would in time sweep off all the vegetable soil, &c., that had previously covered the country, except such portions as were protected by favourable circumstances.

The latter would have been the case in the localities before mentioned, as on the Castlecomer table land, where the præglacial drift was sheltered by the numerous small hills that occur there, and in the Bolleyneendorrish River valley, where it seems to have been preserved by the bars of rock that cross the valley.

Again, that subsequently the country sank, and, as the climate became warmer, the field of ice gradually broke up into local systems of glaciers which flowed down the different valleys. During this process the Secondary striæ would be produced, and the form of the Primary Tors modified.

One of the best places with which I am acquainted for exemplifying the different actions of the "field ice" and of the local glacier is Slieve Bawn, Co. Roscommon. This mountain rises from the central plain of Ireland, as a large "crag and tail," that *tails* towards the N. N. E. (N. 20° E.), and *crags* towards the S. S. W. On the east slope, the primary and secondary striæ are well marked. The primary striæ have a westing as the ground slopes to the eastward; near the foot of the hill where the slope is gradual, being N. 22° W.; and higher up, where it is steep, being N. 32° W. The top of the hill is principally covered with heather and bog, and I observed no striæ. The west slope is banked

* Local name for a valley that runs into a mountain or hill, and is bounded on three sides by precipitous or nearly precipitous sides, answering to the French term *Cul-de-sac*, or the Scotch *Corrie*.

† Bengower (2184 feet), about eight miles east of Clifden, Co. Galway, is polished and dressed to its summit, and Mr. Campbell has recorded on Shanaunnafeola, Co. Galway, horizontal grooves at 2000 feet (See "Frost and Fire," vol. ii., p. 165).

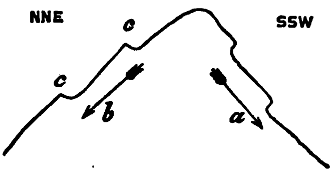
with drift, but at the base the primary striæ run N. 13° E. On the western slopes no secondary striæ were observed, but those on the eastern slopes run with the fall of the ground (about N. 83° E.).

The ice of the ice field on the low country would first be affected by the change in the climate, and gradually slide off into the area now covered by the sea, leaving our present low country to be occupied by the ice supplied from the higher elevations. Part of the latter in its downward passage was caught in the valleys, and on the hill sides, and remained there until it melted, and left its *debris*, which now form the isolated patches of foreign boulder drift. If while these remained in some of the valleys, and in patches on the hill sides, a glacier flowed over, and melted on them, when the ice finally disappeared from the country, it would leave local boulder drift covering foreign. To the northward of large mountain groups, the Boulder drift is sometimes composed of fragments of the rocks from those mountains. In these cases the Boulder drift is the residue of a large glacier that flowed northward from those mountains; an example of this is the Boulder clay of the south part of the county of Mayo, which in a great part consists of fragments of the rocks which compose the Partry mountains.

Good examples of the isolated patches of foreign boulder drift were observed on the mountain group called Slieve Aughta. The rocks composing these mountains are of the Silurian and Old Red Sandstone ages, while the country for miles on the north and north-east is Carboniferous Limestone. In the valleys on the north there are various patches of limestone boulder drift on Silurian and Old Red Sandstone ground.*

If the movement of the ice field was from the N. N. E., it would have carried with it the *debris* of the limestone country on the N. N. E.; and when the climate became warmer, and after this movement ceased, this ice charged with limestone *debris* was on the hills. This mass of ice, going up the hills from the N. N. E. and down the hills towards the S. S. W., had planed all the rocks, leaving a tail towards the N. N. E., and a foil or low cliff towards the S. S. W. (see Fig. 1). But when the field of ice broke up and the ice began to slide down the different slopes, part of it would go with the arrow at (*a*), and, having no impediment, it continued its course down the hill; but some of it went with the arrow at (*b*), part of which was caught behind the *foils* (*c* and *c*), and kept there until it melted, and its *debris* formed the before mentioned patches of limestone boulder drift.†

Fig. 1.



Similar results were remarked on the Arra and Keeper Mountains, county of Tipperary which respec-

* See "Mems. Geological Survey, Ireland," Ex. Sheets 115, 116.

† The author of "Through Norway with a Knapsack" directs attention to the boulder drift under the glaciers in that country.

tively lie N. E. and S. E. of Killaloe.* On the Castlecomer table land, where we have Coal Measures with a limestone country on the N. and N. E.; the hills forming its margin, and some of those in the interior, are free from limestone boulder drift; while other hills in the interior, when there is no fall from them, are covered with it.†

Part of the central plain of Ireland may have been so flat, that, when the movement of the ice field ceased, the ice then on it could not slide away; it would therefore melt where it was, and deposit its *debris*. If this occurred at the base of a mountain group, it would necessarily bank up the ice on the mountain slope, and prevent the greater part of it from sliding down, and therefore the latter would have to melt and deposit its *debris* on the slope of the hills. In this way the continuous sheet of foreign drift up the sides of some hills might be accounted for.

All this time the land is supposed to be sinking; and if we next suppose it to be about 300 or 400 feet lower than its present level, and the climatal conditions of the country to be similar to those of Baffin's Bay and thereabouts at the present day, there would be an open sea in the centre of what is now Ireland, bounded on the north-west and south by numerous ice-clad islands, the depressions between many of which would be occupied by large glaciers; round the land there would be an "Eisfod," or "Icefoot," and numerous icebergs would be floating about in the adjacent waters. But, before we proceed farther, let us consider what would have been the effects of "the Baltic current,"‡ instead of a large ice field.

Mr. Campbell, in "Frost and Fire," seems to consider that at the beginning of the glacial period the land was sinking, instead of rising; and that as it sank, and the current from the North Pole, *viâ* the Baltic, became deeper, the climate gradually became colder; that the land afterwards rose, while the climate gradually became warmer, as the Baltic current became shallow.

Before the country sank, it must have been as high as it is now, or its climatal condition must have been very similar, as the vegetable remains found in the præglacial drift of Ireland and England are like what grow at the present day.§ During the depression and uplifting of the country, marine action would cut out the principal features; and when it rose high enough for land ice to form, a new denuding force

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* See "Mems. Geological Survey, Ireland," Ex. Sheet 134.

† See "Mems. Geological Survey, Ireland," Ex. Sheet 137, p. 50.

I should mention that all round the Castlecomer table land there is a Carboniferous Limestone country, and as patches of limestone boulder drift are found all down the valley of the River Dinin which leaves it on the south, this case does not prove the drift to have come from the north-east, which would have been proved had granite fragments from the country about Ballintore been found. On looking at my notes I do not find any recorded, but I never carefully looked for them, because while examining that district my attention was principally directed to the coals.

‡ See "Frost and Fire."

§ See "Mems. Geological Survey, Ireland," Ex. Sheets 115 and 116, p. 28; also Lyell's "Antiquity of Man," 2nd Ed., p. 215.

would have been at work to finish the excavation of the valleys and cooms, and leave them nearly as we now find them.*

The results from "the Baltic current" would have been very similar to those from "a field of land ice." Most of the præglacial drift would have been swept away, with the exception of a few small patches which were favourably situated; the floating icebergs would "dress" the rocks, and produce the Primary striæ; the latter would run in their regular course (about N. 30° E.) when the icebergs crossed the open sea, or the tops of the submerged hills; but where an iceberg was too large to float over one of the latter, it would have to coast round it, during which process the primary striæ on the hill's sides would be produced, having a westing if they had to go round the east side of a hill, and an easting if they went round the west side. Afterwards, as the land rose, and the hills became awash, icebergs would strand on them, melt and deposit the boulder drift. This boulder drift would rise with the land, but afterwards the most part of it would be carried off by the glaciers, isolated patches only remaining, that were protected in valleys, or behind *foils*; and if a glacier flowed over one of those isolated patches, when the ice finally melted, it would leave local boulder drift on foreign. The banks of foreign drift up the slopes of the hills would be formed by a large iceberg grounding and melting at their base, and thereby preventing any boulder drift above from being carried down.

The land during all this time was gradually rising; and when Ireland was about 300 feet or 400 feet lower than at present, we may suppose, as previously suggested, that its climatal conditions were similar to those of Baffin's Bay at the present day. I have now brought the two theories to the one point, and before we go farther let us review them.

According to the "Land Ice theory," if the features of the country had not previously been sculptured by marine denudation, the land must first have risen about 10,000 feet higher than at present to allow them to have been formed by atmospheric agencies and ice action.†

During the latter part of the glacial period the land must have sunk to

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* Atmospheric agencies could have done very little work in carving out the features of Ireland *since* the glacial period, as the rocks forming the bottom of all the large valleys and cooms are polished and grooved by ice action. A few of the small valleys and *ailles*, or ravines, especially if the subjacent rock is of a soft nature, may have been cut by atmospheric agencies, but in many of them ice action is visible.

† The reason I mention this particular height is, that "it has been shown by the soundings of Vidal and Hoskyns that on the west of Ireland the sea bed is in the form of a submarine plateau, extending from 50 to nearly 200 miles into the Atlantic, with a depth rarely exceeding 200 fathoms. Beyond the line circumscribed by this depth the plateau suddenly ceases; its edge merges into a slope, which descends at a considerable angle, never stopping until the bottom of the great abyss of the Atlantic is reached at a depth of from 1700 to 2000 fathoms." This slope may have been the margin of the land during the Glacial Period as previously suggested by Professor W. King, of Galway. See "Frazer's Magazine," October, 1868.

at least 300 or 400 feet below its present level;* and subsequently it must have risen again till it attained its present altitude.

According to the "Baltic Current" theory the land must first have been at about its present altitude, or a little higher;† it then gradually sank until all or nearly all was covered with water, and afterwards it gradually rose until it reached its present level. In favour of this theory we find marked terraces, which appear to be ancient sea margins, at various levels, which ought not to exist if the country had been covered by a field of ice. Those on Slieve Aughta are well developed in the neighbourhood of Lough Graney; the highest being at about 1200 feet, and the lowest a little above 300. In the Burren mountains, county of Clare, there are also well-marked terraces; and in the hills of Yar-Connaught, N. W. of Galway town, lines of cliffs were remarked at heights varying from 300 to 1000 feet. Against this view is the following:—If the boulder drift is the *debris* left by ice carried from the N. E. by a great current, it ought to be composed of fragments of rocks that formed hills far away to the N. E.; but all the fragments in the previously mentioned isolated patches of foreign boulder drift seem to be of rocks that are found in the country *immediately* to the N. E., as pointed out when describing the isolated boulder drift patches on Slieve Aughta, &c.

The stumbling-blocks in the way of the ice-field theory are, that incalculable ages of time must have lapsed since the setting-in of the glacial period; and if all these phenomena were caused by land ice, this monstrous glacier must have been at least 2200 feet thick when passing over Ireland, and it must have started near the North Pole, and flowed south-westward far beyond this country; there is no existing glacier at all to be compared to what it must have been.

Let us now return to the "Eisfod," or "Icefoot." Doctor Kane, in the "Arctic Exploration," vol. i., pp. 175, *et sqq.*, says of it:—"In this our high northern harbour, an Icefoot is a perennial growth, clinging to the bold faces of the cliffs, following the sweeps of the bays and the indentation of rivers. This broad platform, although changing with the seasons, never disappears." Afterwards he mentions that "It grows wide where the land is low, and narrow where it is high." Doctor Kane also mentions the quantity of the *debris* of the rocks, &c., which it supports. Let us now suppose that a similar "Icefoot" existed in the country which now is Ireland when it was 300 or 400 feet lower than at present. This "Icefoot" should be charged with *debris*

* I do not mean to say "that the land did not sink lower than 300 or 400 feet;" but what I want to express is, that "a short time previous to the close of the glacial period the land was at about that level." If the country sank lower than this, it would quite change its conditions, as nearly all the land ice would disappear, and as the land again rose a new system of glacier would have to form; in fact, it would bring the country to conditions similar to those Mr. Campbell suggests.

† It might have been 1200 feet higher than at present, and have included the whole of the 200-fathom plateau.

of various kinds, that would be dropped when the ice melted, and would form the banks and shelves which exist near the base of some of the mountains. In favour of this idea we find that these banks agree with Doctor Kane's description of the "Icefoot," as they spread out from the hills where they are sloping, and get narrow where they are precipitous. If these shelves are formed by the *debris* from the melting of the "Icefoot," the irregular ridges of rocky and gravelly drift which are associated with them ought to mark the severity of the different winters; for Doctor Kane remarks, "that in a severe season the Icefoot extends much farther out from the land than during a mild one;" therefore, during the thaw after a severe winter, the *debris* carried by the "Icefoot" would be dropped far out, and form one of the outer ridges; while after a mild winter it would be dropped much nearer in, and form one of the inner ridges. All the different modifications we find in these banks and shelves of drift could be accounted for by circumstances going on at the present day; for where there is gravel and sand, it shows that there was a strong current which washed and sorted the *debris* as it fell from the "Icefoot;" and the rounded bluff hills of drift on the mountain slopes show that a "slide," or a stream, during the thaw, had emptied itself over the "Icefoot."*

Looking at the contour map of Ireland, it will be seen that there is a low tract extending south from Killala Bay by Castlebar, Galway, and Ennis, to the Shannon; this tract seems to be nearly free from esker and boulder drift, and from this and other reasons mentioned in the paper of mine previously referred to,† I suggested that a continuous current flowed here from north to south. If this current existed, we should have the area now occupied by Ireland under the following conditions:—The central plain of Ireland would be a sea that had an open space on the east, and was bounded on the north and south by islands, between

* (See "Arctic Explorations," vol. ii., p. 226.) Since the above was written, I find, Mr. Campbell, in "Frost and Fire," has anticipated me in considering that these shelves of drift on the mountain sides were formed by an "Icefoot." It is very satisfactory to me to find that a man who has watched the "ice engine at work" had come to the same conclusion as one who only had seen "the work done."

† (See "Dublin Quarterly Journal of Science," vol. iv., p. 109.) In that paper, besides the current just mentioned, I suggested that there was also another current that entered toward the N. E., "on the north of Lough Neagh, and from thence flowed by that lough, Cavan, Loughs Ree and Derg, to the mouth of the Shannon." This current could not have been a *continuous* current; for if it were, the various bar eskers which cross that valley would have been swept away; but that some current besides the tidal current existed hereabouts, would seem to be suggested by the breaks in the bar eskers to the north-east of Portumna, and also by the shoal eskers on low ground that exist north from Portumna to Kiltormer. These latter would have been formed by the meeting of this current and the south tidal wave, hereafter to be mentioned.

If Mr. Campbell's Baltic current once existed, the north and south current from Killala to the mouth of the Shannon would be the last trace of the once great current that flowed over this island from the North Pole.

which the tide could ebb and flow, while on the west there would also be islands, but between them and this sea there would be a continuous current, that would prevent the tide having ingress or egress through them; these circumstances ought to make the tidal conditions somewhat similar to those of the present day. If the tidal map of the Irish Sea in Johnson's Physical Atlas be examined, the north and south tidal waves will be seen to meet between Dundalk and the Isle of Man; moreover, if the eskers on the published Sheets of the Geological Map of Ireland be looked at, it will be found that they form a compound bar, occupying a strip of country which stretches nearly east and west from Dublin to Galway; this compound bar consists in parts of well-defined ridges or *bar eskers*, and in other places of *shoal eskers;* the bar eskers from Galway to Tullamore, or thereabouts, are usually on ground under the 250 feet contour line; and from Tullamore to Dublin on ground under the 300 feet contour line, while the shoal eskers towards the west are on ground between the 250 feet and the 300 feet contour line; and towards the east, between the 300 feet and 400 feet contour line. From these facts I would suggest that the land was then between 300 and 400 feet lower than at present, having since risen more toward the east than it did at the west; that the climate was somewhat like that of the region of Baffin's Bay and thereabouts at the present day; that this compound bar of eskers was formed by the meeting of the northern and southern tidal waves, which washed and sorted the boulder drift; and that the complicated structure of this bar is due to the nature of the ground, having to fringe round some islands and submerged hills, to form bars between others, and shoals in the shoal water.*

If this compound bar was formed by the meeting of the northern and southern tidal waves, there ought to be bar eskers in some at least of the straits between the islands which bounded the Esker Sea on the north and south; as in these narrows, the tide could not come in or go out as fast as in the open space on the east; about the northern straits I can give no information, but in all the southern straits with which I am acquainted there are bars. In the valley of the Barrow there is a bar near Bagnalstown; in the Maryborough valley, at that town; in the Shannon valley, south of O'Brien's Bridge; in the Nenagh valley, at Kilmastulla; and in the valley of the Suir, at Tipperary.†

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* While examining the gravels in the eskers, I have never found striated or polished blocks high up in them: near the base I remarked a few; but these latter never had the fresh look of those that are newly extracted from the boulder drift, but rather the appearance of the polished blocks that are found in the bed of a stream after a large flood. Many geologists class the *esker-like* ridges of boulder drift with the true eskers or kaims. This appears to me not to be correct, as in many places the esker gravel is banked against these ridges; and if a section across them is exposed, a well-marked boundary will be found between these two kinds of drift.

† Doctor Kane, in "Arctic Exploration," mentions glaciers that fill up straits between some of the Arctic islands. If a similar phenomenon occurred in one or more of the straits out of the Esker Sea, these strait glaciers, if I may so call them, would be

It will naturally be asked if the eskers were formed by marine currents, why do they not contain fossil shells? The condition of the eskers is against fossil shells now being found in them, as it is of such a porous nature, that they would have decayed away years ago. I remember about fifteen years ago, at a place called the Breaches, seeing a river cut made through the bank of gravel that forms the sea margin between Bray Head and Wicklow. This is quite a recent formation compared with the esker gravel, and yet in it all the shells that were found were so rotten, that they crumbled to pieces on being handled. Furthermore, I believe that the places where shells once were can be observed in the eskers, as in most sections that I have examined, little pockets of "Earth foam" were remarked, which may be the calcareous residue of the shells. In the sandpits N. E. of Carrigogunnel, county of Limerick, there are a great number of them, and in some I imagined that I could even recognise shell forms.*

Furthermore, in favour of the marine origin of the eskers, are the erratic blocks perched on them. These latter will again be mentioned farther on in these Notes.†

The next question to be considered is: Has the east portion of Ireland, since the glacial period, risen more than the west? If my suggestions are correct, the eskers were formed near the close of the glacial period; and the *shoal eskers* are those parts of the eskers which were awash, or had not more than fifty or sixty feet of water on them, while the *bar eskers* were formed in deeper water. Near Galway, the eskers shoal

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more likely to occur among the northern islands than the southern. Of course, if a glacier had filled up a strait, no *bar esker* could now be found in it.

* Mr. Oldham seems to have found fragments of shells in the esker close to the town of Roscrea, county of Tipperary. (See his paper, "Journ. Geol. Soc. Dublin," vol. iii., p. 66.)

† If the eskers in Ireland were formed by the meeting of the tidal waves, the *kaims* in Scotland ought also to have a similar origin. This appears not to be unlikely; for Mr. Stevenson, of Dunse, was kind enough to mark for me, on a map of Scotland, most of the principal kaims, the mass of which occupied a tract of country between the Frith of Clyde and Berwick-on-Tweed. On looking at the tidal map, it will be seen that a faint south tidal wave extends as far north as Berwick. This wave could not have formed the kaims; but, if England and Scotland were lowered from 600 to 800 feet, the tidal conditions would be quite altered; and, in place of a faint wave, the full force of the south tidal wave would sweep up at least as far north as this place.

If the eskers were formed by the meeting of the north and south tidal waves, and if there was during the esker period a continuous current flowing from Killala to the mouth of the Shannon, esker drift ought to have been deposited at the meeting of the tidal waves and that current. High ground (Slieve Aughta and Slieve Bernagh) occurs where the south tidal wave and this current ought to join; but there is low ground to the north, where it and the north tidal wave should meet. The maps of the last-mentioned place have not yet been published by the Geological Survey of Ireland; but Mr. Birmingham, in his papers read before the Society (see its "Journal," vol. viii., pp. 28 and 111), mentions the eskers which occur in that country. These, if formed as I suggest, ought to have a general north and south bearing, unless when going over or round high ground, when, of course, the general bearing would be more or less deflected.

below the 250 feet contour line; in the neighbourhood of Athenry, they shoal above the 250 feet contour line, and are barrier eskers up to about that level. This is well shown about four miles north of Loughrea, where an esker ridge runs S. W. from Ballafa Bridge towards Raford, the highest point in which is 232 feet; a little S. E. of this, about Benmore, the country is over 250 feet, and we find it covered with irregular hills; and if we trace the esker ridge towards the N. E., east of Woodlawn demesne, we find it breaking into a large shoal esker on the high ground there situated; while farther east, between Kilconnell and Ballinasloe, where the ground is not so high, it again becomes a bar esker.

The farther we go east, the higher does the level for the shoal eskers become: east of Tullamore the bar eskers are found above the 250 feet contour; and at the Green Hills, county of Dublin, the 200 feet contour line runs close to the base of the eskers, while there is a rather distinct mound forming part of the esker, the summit of which is 254 feet above the sea, but what seems to be the highest part of the esker is 290 feet. Moreover, crossing into Scotland, we shall find in the neighbourhood of Greenlaw that the Ben Shiel eskers are 700 feet above the sea level.* Besides, if the theory that the eskers were formed by tidal currents before the end of the glacial period is correct, there is evidence in the county of Cork that the ground north of Bantry Bay has not risen more than 140 feet since the ice disappeared from the country. This can be proved in one of the valleys immediately east of Hungry Hill, the valley of the north branch of the Reen River, where striæ may be found winding down an *aille*, and ending at a well-marked terminal moraine, on ground only 140 feet above the present level of the sea. This moraine could never have been under water, or it would have been washed out of shape.†

These facts would give the following levels:—

	Feet.
Maximum height of the sea at Bantry Bay, . .	140
Top of shoal eskers near Galway, ... about	240
Top of shoal eskers east of Athenry (Clooncar), .	269
Top of bar eskers S. S. W. of Woodlawn (S. W. Ballafa Bridge), ...	232
Top of bar esker east of Tullamore, . . . about	270
Top of bar esker, Co. Dublin, Green Hills, . . .	290

Icebergs floating about in the Esker Sea, wafted hither and thither by the currents and the wind, would in their transit drop the erratic blocks

* See paper by Mr. Stevenson, of Dunse, "Proceedings Berwickshire Nat. Club," vol. v., p. 124.

† As the highest ground in Ireland lies in the counties of Cork and Kerry, the glaciers may have existed thereabouts after they had disappeared from the rest of Ireland, and therefore after the age in which the eskers were formed. If that was the case, this terminal moraine may have been formed at a much later date than I have mentioned above.

that are found perched on the esker drift,* and also some of those which occur on the boulder drift, but seemingly not all, as many of the blocks on the boulder drift appear to be its residue, left after the associated clay, &c., were carried away. There are to be found on the crags in the county of Galway numerous large blocks, most of which are evidently the residue of the boulder drift, as under some of them are found patches of it; and if the residue of the boulder drift was left on the crags, why might not similar blocks be left on the boulder drift, if only part of the mass had been swept away? We also find in favour of this idea that some of the blocks which seem to be lying on the boulder drift are in reality half buried in it. That some of the blocks even on the bare crags were dropped from icebergs would appear evident, because in places they can be traced in lines from their parent rocks, and in others they occur in groups, small and large blocks being mixed together, evidently the freight of a stranded iceberg. If these icebergs and glaciers existed during the esker period, their existence would account for the erratics being found miles east, and even north, of the course they would have taken if carried either by the "field ice," or on icebergs in the "Baltic current."

A peculiar porphyritic granite, with large pink, or rather flesh-coloured crystals of felspar, is the rock in the hills N.W. and W. of Galway town. Large blocks of this granite are found north, east, and south-east of their present site. They are found north of it in the valley that extends west from Oughterard, a small town about fourteen miles N.W. of Galway town. In the neighbourhood of Headford, which lies east of Oughterard, they are rare; but opposite Galway Bay they become plentiful, and stretch for miles towards the east, occurring in great numbers between Woodlawn and Loughrea; and some I have remarked as far east as Ballinasloe, Eyrecourt, and Portumna; and Mr. O'Kelly has found them even farther east, on Slieve Bloom, the mountains that lie at the junction of the King's and Queen's Counties.†

On the west parts of Slieve Aughta, and on Slieve Bernagh (the mountain group north of Limerick), they occur; but I do not remember having remarked any of very large size. Opposite the mouth of the Shannon they are found a long way to the east, Professor Haughton and Mr. A. B. Wynne having noted large ones in the neighbourhood of the Silvermines, county of Tipperary: and I myself have remarked that drift in some of the valleys on the west of the Keeper Mountains is nearly entirely made up of granite fragments.

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* For some *locale* of remarkable erratics on eskers see "Mems. Geol. Survey of Ireland," Ex. Sheets 115 and 116, p. 34, and the forthcoming Mems. of Sheets 106 and 107. All these are granite erratics; but a large limestone erratic, about 8 ft. × 6 ft. × 3 ft. can be seen by any one who drives from Gort to Loughrea, perched on a sand dun, about 2·5 miles south-west of the latter place; and in the county of Limerick, south of Shanagolden, I observed another, about 9 ft. × 5 ft. × 3 ft., also perched on a sand dun. In both these places the duns have been opened to carry away the sand and gravel, so that a section of the materials that support the erratics can be observed.

† See "Mems. Geol. Survey, Ireland," Ex. Sheet 127.

I shall offer the following suggestions to account for these blocks being more numerous in certain places than in others:—The Oughterard valley was filled with a glacier similar to one of the large glaciers mentioned by Dr. Kane, as occupying straits between islands in the Arctic Seas. This Oughterard glacier would have southern branches which started from the porphyritic granite hills; and on these branches porphyritic granite blocks would be carried to the main glacier, and by the latter to Oughterard, where they would be floated off on icebergs into the previously mentioned current that ran from Killala to the Shannon. The icebergs that were launched into this stream ought to have been carried south by its current, and undoubtedly many were; but if the west wind was as prevalent then as now, which is not unlikely, many of the icebergs would have been driven out of the stream. The icebergs floating down with this stream were sheltered from the west wind, except while crossing the openings at Galway Bay, the Ennistymon valley, and the mouth of the Shannon, therefore the icebergs that were launched at Oughterard ought to float to Galway Bay; but when there, some were driven east by the west wind, many of which were stranded on the high ground about Loughrea, Woodlawn, &c., while others of them were driven as far east as Slieve Bloom. Similarly the blocks in the neighbourhood of Silvermines could be accounted for; as the icebergs that carried them might have been driven eastward by the wind that came either through the Ennistymon valley, or up the mouth of the Shannon. In the former case they would have been floated through the Scariff valley, which lies between Slieve Aughta and Slieve Bernagh, in the latter case up the valley of the Shannon.

Some of the icebergs that were driven out of their course by the wind that blew up the valley of the Shannon would drop their freight in the country south of Limerick, and on the Galtee mountains, where they were found by Mr. Wynne;* and a few might even be carried south by the tide into the county of Cork, which would account for the granite boulders found by Mr. W. L. Willson and other observers.

Before leaving the erratic blocks, I should mention that S. W. of Woodlawn, a little S. W. of Ballafa Bridge, large blocks of the porphyritic granite are found perched on the eskers there situated; and that farther S. W., south of Raford, they were also observed on esker drift, and Mr. Foot has found them similarly circumstanced in the neighbourhood of Ballinasloe.

These facts about the erratic blocks would seem to me to be additional evidence in favour of a north and south current from Killala Bay to the Shannon. Moreover, there is the evidence that I put forward in the previously quoted paper of mine, that the drift on the hills bounding the Shannon on the south, from Foynes to Tarbert, is in a great measure made up of fragments of the rocks that form the hills in the west parts of Galway and Mayo, in some places being altogether com-

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* See "Mems. Geological Survey, Ireland," Ex. Sheet 165.

posed of them. Besides, if this current existed, it would always be inclined to go west, and therefore it would hug the Yar-Connaught and west of Clare hills. At the mouth of most of the mountain valleys in Ireland there is an accumulation of drift, the *debris* brought down by the glaciers; as, for instance, opposite the valleys coming out of Slieve Aughta, Slieve Bernagh, &c.; but, comparatively speaking, there is none opposite the valleys that open towards the east out of the Yar-Connaught and west of Clare hills, it having been carried away by this current.

In conclusion, allow me to allude to the different cliffs, terraces, &c., which seem to be ancient sea margins. In a previous part of these Notes I have referred to those in Yar-Connaught, Slieve Aughta, and the Burren, and mentioned that they were at various heights between 300 and 1200 feet. If these were ancient sea margins, during the elevation of the land, each must mark a period of rest, one of which periods may have been during the formation of the eskers. That there was a period of rest while the eskers were being formed is likely, if the idea "that the west of Ireland was about 300 feet lower than at present" be correct; for, as before mentioned, there are terraces at that height in Yar-Connaught, Slieve Aughta, and the Burren hills. To the west of Ballingarry, county of Limerick, and about four miles south of Rathkeale, I traced a well-marked gravelly beach for miles. The Ordnance height on this beach, or a little above it, is 287 feet; and to the north of the Shannon, on the south slopes of the Cratloe hills, there is a bank of fine sand at about the same level: these would give the following height for the margin of the Esker Sea in the West of Ireland:*—

	Feet.
Limerick, ...	287
Clare, south of (north slopes of Cratloe hills), about	290
,, north of (Burren hills), ...	300
,, ,, (Slieve Aughta), ...	300
Galway, south of (Slieve Aughta), ...	300
,, west of (Yar-Connaught)	300

* The heights of the margin of the supposed Esker Sea in the east of Ireland are not given, as I have not carefully examined that part of the country.

In the following papers reference is made to marine fossils found in gravelly drift, principally in the east part of Ireland:—

"Account of certain elevated Hills of Gravel containing Marine Shells which occur in the County of Dublin," by Dr. Scouler, &c., &c. ("Journal of the Geological Society of Dublin," vol. i., p. 266). The author mentioned having found these shells at Howth up to an elevation of about ninety feet, and on the south of Bray Head at about 150 feet. Of them he says, "All the shells whose species could be ascertained belong to races at present existing in the Bay of Dublin."

"On the more recent Geological Deposits in Ireland," by T. Oldham, M. R. I. A., &c. ("Journal of the Geological Society of Dublin," vol. iii., p. 61). In this Paper, Dr. Oldham, besides adding to Dr. Scouler's list, refers to Captain Portlock having found marine shells at 200 ft. above the sea in the county of Sligo, and in the county of Londonderry up to 300 feet; to Messrs. Bryce and Hyndman, at Belfast, up to 150 feet;

I have now laid before the Society suggestions to account for the different phenomena that I have remarked connected with the drift in Ireland; and I think it will be found in favour of these suggestions, that all the phenomena have been produced by *existing agencies, gradual in their process, and such as have been noted by different Arctic observers.* The north and south current, from Killala Bay to the Shannon, may be objected to, as it may be said, "If it prevented the tide from going east between Killala and the mouth of the Shannon, it would also prevent it farther north, and so altogether change the tidal system." But farther north, where the ocean was deep, might not the tide have flowed over this current, as it is supposed to flow over an Arctic current at the present day off the west of Ireland?

In these Notes no suggestions have been offered to account for "the rudely parallel esker-like ridges of boulder drift" that are found in wide valleys and on sloping ground. All I can say about them is, that they seem to be connected with the secondary striæ; for I have found them running in the same direction in the valley between Slieve

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to Mr. Smyth, at Portrush, at about ten feet; and to Mr. (now Sir R.) Griffith, at Tarmon Hill, county of Mayo, at 250 feet. He also mentions the following localities of his own, with their height above the sea:—Telegraph Hill, Killiney, 400 feet; N. W. side of Sugarloaf, county of Wicklow, 600 feet; south of Wicklow Head; between Enniscorthy and Wexford, 250 feet; Finglas, county of Dublin, 200 feet; Clane, county of Kildare; Naas, 380 feet; between Athy and Castlecomer, on the flanks of the ēlevated coal-field; and at Roscrea, 400 feet."

In a second paper by the same author (see "Journal of the Geological Society of Dublin, vol. iii., p. 130), the previous list of marine shells in the county of Dublin is added to—"making in all twenty-six species."

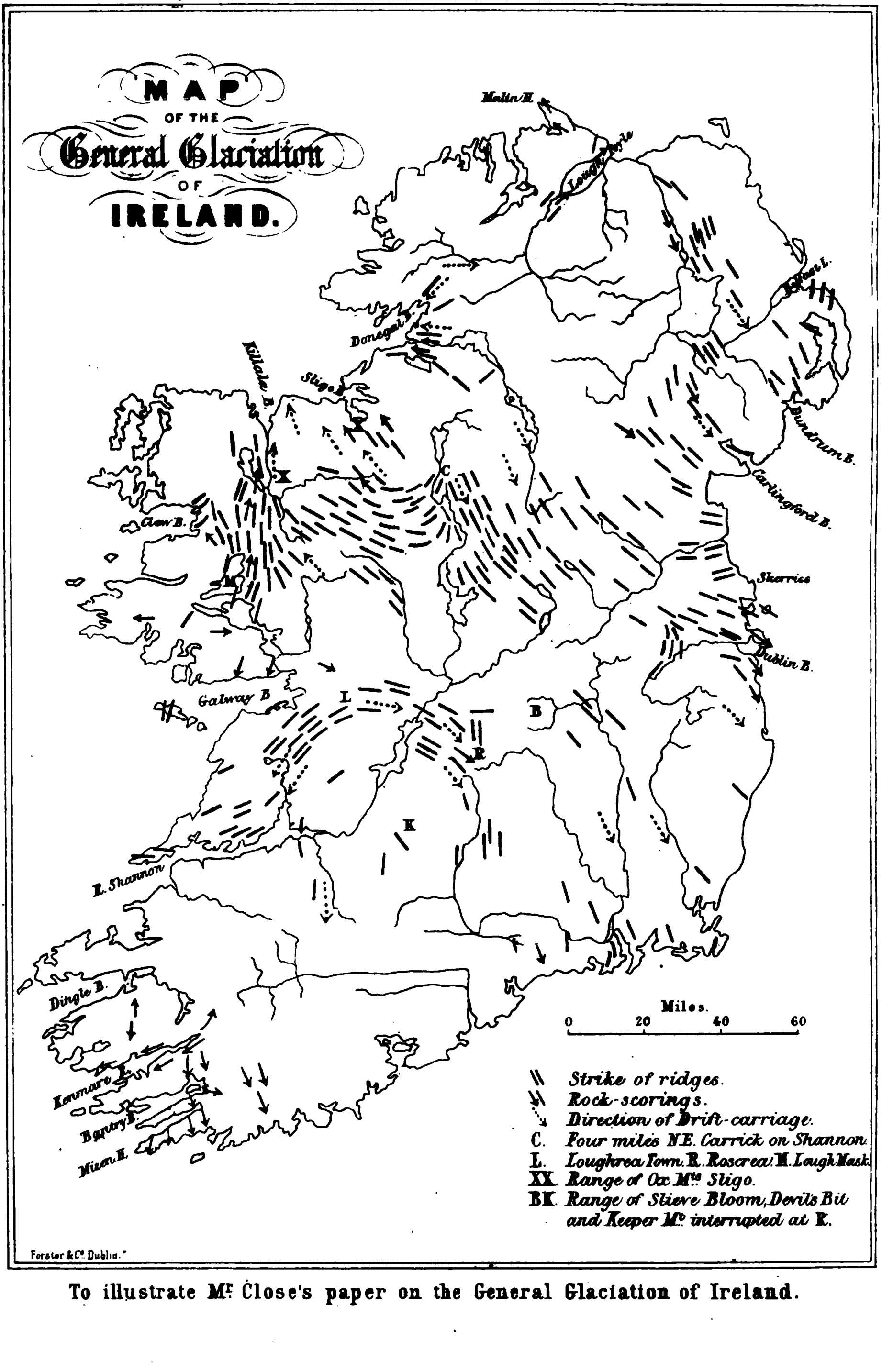
Captain James, R. E. (now Sir H. James) gave a paper—"Notes on the Tertiary Deposits of the County Wexford" ("Journal of the Geological Society of Dublin," vol. iii., p. 195)—and mentions seventy-four species of marine shells, the highest of which "were found at an altitude of 400 feet on the side of Forth Mountain;" but these, as previously mentioned, he seems to consider, as occurring in Præglacial Drift.

Mr. Du Noyer (see "Journal of the Geological Society of Dublin," vol. iii., p. 225) found marine shells at different places in the cuttings for the Dublin and Drogheda Railway. At Skerries he mentions that "the railway cuts through an esker," and "the calcareous clay overlying this sand and gravel contains many sea shells of the same species as those now living." He also says that at the twenty-six mile post, and near the Nanny Water, there are deposits "containing quantities of recent sea shells, bones of fish, teeth and bones of animal." (*Quere*, might not these be ancient kitchen middens?)

Dr. Kinahan (see "Journal of the Geological Society of Dublin," vol. viii., p. 87) is mentioned as having found marine shells in the drift at Bohernabreena, county of Dublin. Of these my colleague, Mr. W. H. Baily, says—"None of them are strictly Arctic, and most, if not all, are found in the seas round Ireland at the present day." It is not mentioned at what height these shells occur, but the gravels at Bohernabreena are between 400 and 450 feet above the sea level.

Some of these gravels may have been deposited towards the end or after the Esker Drift period, when the sea was losing its Arctic character.

In the counties of Limerick and Galway, at low levels, there are what seem to be ancient sea beaches; but as they are on lower ground than that occupied by the eskers, they seem to me to be more recent, and therefore will not be further mentioned in these Notes; but I hope to describe those found in the county of Galway in a forthcoming Memoir of the Geological Survey.



To illustrate Mr. Close's paper on the General Glaciation of Ireland.

Aughta and the Burren Hills, also in valleys in Yar-Connaught, and in the plains of Mayo. In the Scariff valley they coincide with the fall of the valley, and lie in the direction that the secondary striæ ought to run, and the same thing can be said of the part of the valley of the Shannon south of Killaloe. Mr. Close has recorded them in the county of Dublin as running in the same direction as striæ; but the latter he seems to consider as primary.

Some of the foregoing theories coincide with those of previous writers, but many I believe are new, and are based on personal observation. Possibly I may have been anticipated by observers whose works have not come under my notice.

XXVII.—Notes on the General Glaciation of Ireland. By the Rev. Maxwell H. Close.

(Plate VIII.)

[Read March 14, 1866.]

The accompanying map (Plate VIII.) exhibits the directions of the parallel surface conformation, the rock-scoring, and the drift-transportation in various parts of Ireland. The three kinds of phenomena are manifestly related to each other as effects of a common cause—they are the traces left by certain streams, whose nature and movements it is proposed to investigate.[1]

It is the belief of many geologists, who have bestowed especial attention on the matter, that the streams which have produced such phenomena must have consisted of *glacier*-ice. Strong reasons in support of this belief will appear after we have considered the facts and their relations; but in the mean time we may assume it to be correct; and, in order to avoid circumlocution, speak of "the ice," "the glaciation," &c., whenever it may be convenient to do so.

Our proper subject is the *general* glaciation of the country. This may have been, to some extent, contemporaneous with, and has probably merged into, the radiating *district* glaciation of which we find areas in different parts of Ireland. It will be necessary, therefore,

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[1] *Explanation of the Map.*—The red strokes represent rock striations. These are made into *arrows* when the striations show, of themselves, not merely the line of the movement, but its direction in that line. The black strokes give the trend of the parallel ridging in the places where they are set down. They are made into arrows in East Derry, after Portlock, for a reason similar to that just given for the red arrows, and I believe might have been so in certain other places; but, as there were some difficulties connected with the matter, it seemed safer to leave them plain lines. The dotted arrows show the directions in which the drifted materials have moved: in most cases certainly, and in others most probably, they give the movement of the *boulder-clay*. It was found impossible to represent the mountain masses sufficiently for our present purpose, without confusing the map too much. See the Contour Map of Ireland, made for the Land Tenure Commissioners, or the reduced copy of it in Sir R. Kane's "Industrial Resources of Ireland" (2nd ed.).

N. B.—The notes are numbered consecutively throughout, in order that, when necessary, the same note may be referred to by the same number in different parts of the paper.

to mention some instances of the latter. But the still later separate *local* glaciers, which descended from their own mountains, on which they were formed, are beyond the limits to which we must confine ourselves.

This paper originated in the endeavour to trace backwards, along its strike, the parallel ridging so well displayed in the neighbourhood of Dublin. It was found that this peculiar surface-conformation is developed over considerable portions of the lower ground in Ireland, and that the greater part of the dissimilar phenomena of rock-scoring and drift transportation are related, since they so constantly agree therewith as to direction. In consequence of this agreement, the parallel ridging often supplements and links together the detached phenomena of the two other classes, and thus affords a useful clue to their real connexion. This it does notably in the west-central part of the country.

On the completion of the Geological Survey, and of the shaded edition of the Ordnance Maps of Ireland, we shall be in possession of far more copious materials on which to work. But the already available information to be collected from various sources seems to be of sufficient amount to justify our examining it even now, with some hope of getting at its meaning. For some information, not hitherto published, respecting the central and west-central districts, we are indebted to Messrs. Kinahan and Foot, of the Geological Survey. Mr. Jukes has kindly permitted us to make use of this, although it has not yet appeared in the Memoirs of the Survey.

The parallel ridging.—The parallel ridges, whose directions are marked on the map, constitute very minor physical features, influencing only the small streams and upper branches of rivers. They nearly always consist of drift, but occasionally the parallel shaping seems to be in some degree wrought in the solid rock; *e. g.*, in Antrim,[2] as stated by Mr. Bryce, and as I have myself observed; in Longford (and perhaps in Clare,[3] to the south-west of Ennis), according to Mr. Foot; and near Dublin, as I have myself been led to believe. In some cases a boss of rock has acted as the impediment which caused the drift to collect into a ridge behind it. Sometimes we find more important physical features (not composed of drift) which may possibly belong, to some extent, to the same system as the smaller ridges in their neighbourhood; but we shall not go into this now, for fear of introducing what may be questionable matter.

The lines representing the direction of the parallel ridges were, for the most part, set down in the first instance from the unshaded maps of the Ordnance Survey. Those maps indicate most clearly, in many districts, this peculiar conformation of the surface of the country by the number of streams, bogs, lakes, roads, fences, and boundaries which run along the strike of the ridging. Of course, in good shaded maps of sufficiently large scale, this phenomenon is still more observable; as will appear on refe-

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[2] "Journal of the Geological Society of Dublin," vol. i., p. 34.

[3] Explanations to Maps of Geological Survey, Sheet 131, &c., p. 15.

rence to the maps of portions of the country, made to illustrate the Report to Parliament on the Bogs of Ireland, Bald's Map of Mayo, Edgeworth and Griffith's Map of Roscommon, Larkin's Map of Sligo, and some of the already shaded sheets of the Ordnance Map of Ireland, especially those containing parts of Antrim, and the country near and north of the city of Dublin. To these we must add some of the sheets of the Geological Survey Maps, published up to this date, on which, in Clare, South Galway, and thence to Roscrea, the ridging is very discernible by the elongated patches of buff colour which indicate the alluvium and bogs lying along the hollows, and also by the fact that some of the more striking of the ridges are shaded in. By making use of all these sources of information, we are enabled to fill up most satisfactorily, in many places, the comparatively meagre sketch to be made from the unshaded maps.

The parallel ridging in various places has been, moreover, described by various observers—in Derry, Antrim, &c., by Mr. Bryce[2] and General Portlock;[4] in Donegal, by Mr. Harte;[5] near Ballyshannon, by Mr. Campbell;[6] in Mayo and Sligo, by Sir R. Griffith;[7] in South Mayo, by Mr. Kinahan; in Roscommon, South Leitrim, and Longford, by Mr. Foot; in Westmeath, by Mr. Du Noyer; near Portrane, county Dublin, by Mr. Medlicott;[8] in Galway, by Mr. Birmingham;[9] in South Galway,[10] and North Clare,[11] by Mr. Kinahan; in South Clare, eastward of Kilrush, by Mr. Foot;[12] in North Limerick, about Pallaskenry, by Mr. Kinahan;[13] and in the north-west neighbourhood of Roscrea by Mr. Wynne.[14]

General Portlock[15] has mentioned a fact which is evidently connected *partly* with our subject, and that is, "the remarkable similarity of direction of almost all the lakes and chains of lakes which intersect the area of Ireland." Respecting this he observes, "This can surely not be ascribed to chance, but strongly points to a common and simultaneous cause." The direction of the longer axes of these lakes is about N. W. and S. E., nearly at right angles to that of most of the hill ranges in Ireland. The smaller lakes of Westmeath illustrate General Portlock's remark very strikingly; they unquestionably belong to the parallel ridge-and-trough conformation which we have to consider, and are in no way connected with any "transverse valleys."

[The rudely parallel ridges and mounds *at* Roscrea are eskers; with them, therefore, as we shall see presently, we now have nothing to do,

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4 "Geological Report on Londonderry," &c., ch. 13.
5 "Journal of the Royal Geological Society of Ireland," vol. i., p. 21.
6 "Frost and Fire," vol. ii., p. 53.
7 "Outline of Geology of Ireland."
8 "Journal of the Geological Society of Dublin," vol. v., p. 265.
9 Ibid., vol. viii., p. 31.
10 Ex. Sheet 115, &c., pp. 30, 32.
11 Ex. Sheet 124, &c., pp. 45, 47.
12 Ex. Sheet 142, p. 5.
13 Ex. Sheet 143, p. 33.
14 Ex. Sheet 126, pp. 7, 13.
15 "Journal of the Geological Society of Dublin," vol. i., p. 11.

although they have the same direction as the ridging in that neighbourhood with which we are concerned. We omit the remarkable mounds of boulder-clay near Bantry, described by Mr. Jukes;[16] because their parallelism, if there be really any, is so very obscurely marked, that they are not available for determining the direction of any stream by which they may have been formed. For the same reason, the mounds of drift in the Kilmastullagh valley, between Nenagh and Castleconnell, are omitted, and also because some of them, according to description, must be eskers, though others appear to me not to be so. Some north-west and south-east ridges in Tyrone, near Dungannon, and elsewhere, recorded by Mr. Bryce and General Portlock, are ignored. They may have a right to appear in the map, but I have not sufficient evidence of this.]

Those of the parallel ridges which consist of drift are totally distinct from eskers as to composition, and almost always so as to arrangement; moreover, they differ, as to form, from *typical* eskers. As I learn from other observers, and as I can testify myself, they are composed of unstratified *boulder-clay*, containing well-blunted and scratched blocks; whereas eskers consist of washed and sorted, usually water-rolled and stratified materials, derived, as it seems, chiefly *from* the boulder-clay. The boulder-clay ridges may be, as in certain localities, very irregular; but those with which we have to do, whose directions are marked on the map, are remarkably straight and parallel; whereas esker ridges are usually irregular, often very sinuous, and without any general direction. If the latter are ever either straight or parallel, it is a very rare circumstance, and, with some very few exceptions, apparently the result of accident only; and their straightness and parallelism are quite of a peculiar character. Moreover, the parallel boulder-clay ridges are usually higher, wider, and rather less steep on the sides than average esker *ridges;* besides, they are generally more uniform in size in a neighbourhood. The distinction, as to external form, between the two kinds of ridges, can be well seen in the shaded Ordnance Map of the country about Dublin, which shows the parallel ones very plainly, and also several well-marked eskers, viz., that between Tallaght and Crumlin; that at Esker, near Lucan; that at Kilbride cross-roads; and the fine specimen on the south-east of Trim, five miles in length, which is inclined to the parallel ridges at an angle of about 20°. Any one looking at Bald's Map of Mayo, although quite unacquainted with the subject, would at once point out the eskers near Ballyhaunis and Claremorris, as also those near Kilkelly (which last I have not seen myself), as being altogether different in character from the other ridges represented in that district, which are those of boulder-clay, generally straight and parallel, though sometimes irregular. A mere examination of the maps now mentioned would be, of itself, sufficient to show that the parallel drift ridges were produced by some widely and uniformly working agent,

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[16] Ex. Sheet 199, p. 45.

and that the eskers were afterwards formed by some peculiar and irregular action, which came into play only here and there. The parallel drift ridges sometimes have slightly-marked subordinate longitudinal features; they always seem to have been formed by something that acted along their length; whereas esker ridges seldom suggest such an idea.

In the Explanations of the Geological Survey Maps, Messrs. Du Noyer, Wynne, and Kinahan sometimes distinguish the parallel drift ridges as "esker-*like* mounds;" and in the Explanations (just out) of Sheets 115 and 116 of those maps, Mr. Kinahan pointedly and expressly separates the two sorts of ridges, which coexist in the district represented in those sheets. General Portlock[4] speaks of the banks of drift which, in East Derry, stream from the basaltic knolls towards the S. S. E. (and are therefore parallel with each other), as differing, both in form and mode of formation, from the eskers in West Tyrone. Mr. R. Young,[17] also, perceived that the "diluvial ridges" of the central parts of Ireland are of two different kinds, though occasionally resembling one another in form:—(1) those gravel hills which are sometimes confounded with eskers, but are distinct in character, and have little appearance of stratification in them; and (2) the eskers proper. He has constructed a map to show the probable direction of the currents across the central plain of Ireland.

In different places in Mayo, and near Maynooth, county Dublin, about five of the parallel ridges come in in the breadth of a mile; usually, however, they are wider, or at least farther apart. They vary in length from a quarter of a mile to two and a half miles; the average and most usual length is somewhat less than three-quarters of a mile. Many of those near Westport are about 100 feet high; some more. Those near Ballyshannon have about the same general height. Some, six miles northward of that place, and west of Ballintra, to judge from their appearance at a little distance, must be over 150 feet in height. *Some*, in Dublin and Westmeath, form very gentle undulations, not more than thirty feet high.

Fine sections are made in these ridges by the railway in South Sligo; but perhaps the most striking are those near Balla, in Mayo, where the ridges are very well defined, and the railway cuts less obliquely through them.

The "long banks of boulder clay," in Scotland, mentioned by Mr. Geikie,[18] as telling of the passage of the great ice flow, are evidently identical with these; whilst, as is well known, the kames of that country are eskers.

Since the two kinds of detrital ridges are essentially different, and since it will be necessary to mention both repeatedly, it will be convenient to distinguish them by proper appellations. The name "esker" is that by which one kind is familiarly known in this country; and it

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17 "British Association Report," 1852, Sections, p. 63.
18 "Glacial Drift of Scotland," p. 85.

seems allowable that that which has been applied to the other should be, on the present occasion, appropriated thereto. Mr. Bryce[2] tells us that these parallel ridges of drift, in the North of Ireland, which General Portlock shows to be different from eskers, are called there "*drumlins*;" which name we may use in this paper to designate those detrital ridges with which we are now especially engaged.[19]

A slight digression may be permitted here.—The facts to be observed in this country seem to throw light on a difficulty respecting the Swedish *åsar*. Although no single writer that I know of expressly states as much, the very dissimilar accounts given by different eminent observers make it most reasonable to conclude that the ridges which are comprehended under that name are of two essentially distinct classes. The Irish phenomena confirm this conclusion. The ridges which chiefly attracted the attention of Brongniart,[20] Durocher,[21] Murchison,[22] and Kjerulf,[23] must answer to our parallel drumlins; some of those which were more particularly examined by Lyell[24] and Chambers[25] must correspond to our eskers (some of these, however, may possibly be drumlins in masquerade). It is with the former that we are at present more especially concerned. The descriptions (though not the theories) of them given by the four above-named writers corroborate and supplement each other. We learn from the descriptions that those ridges are long, narrow banks of clay, gravel, and blocks, "avec un parallélisme très remarquable," having the same direction as the rock striations, often as much as from 100 to 200 feet in height, and occasionally, though but seldom, reaching even 300 feet, generally not more than a mile in length, though sometimes forming an extended series. They occur, like our drumlins (and indeed eskers), only in the lower parts of the country. They often have a number of large angular blocks resting on their surfaces; but the blocks within them are well rounded, the rounding having been effected, as Kjerulf is careful to point out, not by rolling, but by scratching. They are quite distinct from the stratified, shell-bearing detrital deposits of the same country, which constitute a later formation. It must, therefore, be unquestionably wrong to confound *such åsar* with eskers and kames.

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19 "Esker" and "drumlin" both mean, originally, nothing more than a ridge-shaped hill of any kind; but if "esker" has been, in accordance with general popular usage, technically appropriated to one kind of detrital ridge, "drumlin" may be so now to the other, to which it is actually applied in the North of Ireland. However, according to Mr. Bryce's and Dr. Scouler's ("Journal of the Geological Society of Dublin," vol. i., p. 273) descriptions, some of the ridges called "drumlins" in the North are eskers. Many of the ridges in Mayo, Roscommon, South Leitrim, &c., are called "*cloons*"—as Cloonfannon, Cloonmore, &c.; but this is only in reference to their so often forming isolated portions of fertile, because dry, ground in the midst of boggy or undrained land.

20 "Ann. des Sciences nat.," vol. xiv., 1828.

21 "Comptes rendus de l'Acad. des Sciences," vol. xiv., 1842, p. 59.

22 "Geology of Russia," vol. i., ch. 21.

23 "Edinb. N. Phil. Journ.," vol. xviii., 1863.

24 "Upraised Deposits in Sweden," Phil. Trans., 1835.

25 "Ed. N. Ph. Journ.," vol. liv., 1853.

To return from this digression.—The parallel drumlins essentially consist of true boulder-clay, and, as we shall see presently, have not been formed by water; yet they may perhaps sometimes have their upper parts stratified by water action, just as the upper part of the level deposits of the same formation sometimes is. Where that action has proceeded far enough, the parallel conformation is, of course, either partially or wholly obliterated; as seems to have happened in the King's County, and its neighbourhood, where the eskers have been so remarkably developed. The same thing, apparently, has taken place in Carlow. It seems wonderful that the drumlins should have so extensively escaped demolition while submerged, as they once were, beneath the Pleistocene sea; but the explanation is found in the usually moderate action of that sea, as often proved by the state of its deposits and the included shells, and also in the compactness and toughness of the boulder clay, armed as it was with its pebbles and blocks. Kjerulf speaks of the above-mentioned unstratified ridges in Sweden as often rising from beneath level, water-formed collections of sand,[26] &c., and as being sometimes buried therein without being destroyed; the position of the concealed *ås* being indicated only by a lake or a stream, the water of which was unable to work its way through.

The rock-scorings and drift-transportation.—It will be most convenient to describe these together; first premising some necessary remarks respecting each. As to the rock scorings—Those represented on the map are in the great majority of cases the only ones, but sometimes they are but the oldest ones visible in the different places. Cross striations, later than the principal ones, frequently occur. These are evidently due not merely to an unsteadiness in the motion of the striating agent, but to a quite distinct transverse movement. In some cases the transverse movement seems to have had much persistency over a considerable area. These cross striations, later than the others, have been found by Mr. Kinahan, in Mayo, Galway and Clare; by Mr. Foot, in South Leitrim; and by myself, at Greystones, Co. Wicklow, and in several places along the railway near Ballyshannon, and at Malin, in Innishowen, and near Bangor, on Belfast Lough. They are very interesting in themselves, yet they have been omitted on the map for the following reason:—The great majority of them occur on the same surfaces with the others, this being the circumstance that enables us to see which are the older, and which the later. Usually the older set has suffered no obscuration, or very little, by the transverse movement which has produced the later set of striations. The transverse movement must have been, therefore, a very slight one, which took place after the great glacial movement had ceased. It is possible that some of the cross striations were produced by floating ice; others, however, cannot have been so, since, as Mr. Kinahan informs me, they so

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[26] Some of the island drumlins in Clew Bay are so situated. The sand, however, has been formed by the present sea, which has sometimes escarped the outer ends of those islands.

often follow the fall of the ground. It is conceivable that, as the ice-covering of the country was finally wasting away, new mechanical relations would arise among different portions of it, and also between it and the inequalities of the ground. It is, indeed, a matter of surprise that the *latest* motions caused thereby were not more important than they appear to have been. (Observe, we are now speaking only of the older and later striations *now visible* in any place. It may be, as we shall see presently, that the *oldest* rock scorings near Ballyshannon, for instance, have been entirely removed.) We are clearly justified in separating the cross striations from our present subject, and taking no farther notice of them.

As to the drift transportation—The question of the formation and carriage of the superficial detrital deposits is a very difficult one, not only on account of its present obscurity, arising from the incompleteness of our knowledge respecting it, but also because of its great complexity. It is, however, an unquestionable fact that, of those deposits, the boulder-clay is the one which is most intimately connected with the rock striations. This is acknowledged by persons who hold very different views as to the agency by which the boulder-clay and rock striations were produced. The stratified water-formed deposits frequently contain an admixture of far-transported stones, such as do not occur in the boulder-clay of their neighbourhood; still the greater part of their materials seems to have been generally derived from the boulder-clay beneath or near them. Hence the general direction in which the bulk of the stratified gravels, &c. seems to have been carried, must often agree with the movement of the boulder-clay. In the following information, derived from various sources, respecting the carriage of detrital materials, the distinction between the boulder-clay and the overlying stratified stuff has not always been expressly drawn; it will, therefore, be sometimes necessary to use the word "drift" in a loose sense. Still, if the movement of the boulder-clay be closely, and that of the bulk of the stratified deposits be remotely, connected with the rock striations, we may hope that this looseness will not be of serious consequence as respects our present object.

To begin, then, at the north of Ireland. General Portlock[4] and Mr. Bryce[5] show that the bulk of the drifted matter in Antrim, Derry, Tyrone, and Down has moved from north-westward to south-eastward; which agrees with the fact above mentioned, that in East Derry the banks of drift stream from the rock knolls to S. S. E. (see, however, the section on "independently transported materials," *infra*). I myself saw some evidence of this a little north and a little south of Newry. Many blocks of granite, some well ground and striated, may be seen lying on the Silurian ground about Kilkeel, &c., to the S. E. of the Mourne granite mountains (where there is, however, much stratified drift). I gather from Mr. Bryce's statements, that the blocks of Mourne granite have *chiefly* gone in the direction now mentioned.

The strike or lie of the rock-scorings in that region corresponds. About 3½ miles from Ballymoney, on the new road to Coleraine, at See-

caun quarry, smoothing and striations, N. W. by W., were found by me on basalt. It was impossible to say in which direction the grinding agent moved along the lines. The drift by which the glaciated rock is covered betrays the action of water in one part where there is some clean sand. It contains, moreover, buried in it a few small bits of red granite which are perfectly unworn either by rolling or scratching—another indication of water action, since it seems impossible to account for the presence of such far-travelled stones in such condition except by the agency of floating ice. Near Cullybackey, at the distance of about three-quarters of a mile on the road to Ballyconnelly cross-roads, striations may be seen at a basalt quarry, N. N. W. Also on the same rock, at the very cross-roads, 1½ mile S. W. of Cullybackey — a good example. These are parallel to the others; but it must be confessed that they *rather* look as if the grinding movement was towards the N. N. W.; this, however, I suppose, must be impossible. N. B.—A great many eskers, recognisable not merely by their characteristic forms, but also by the numerous sections made in them by gravel pits, occur along the railway nearly all the way from Cullybackey to the vicinity of Ballymoney. These have nothing to do with the parallel ridging, which, as abovementioned, is formed of boulder-clay and seems to be also, to some extent, wrought in the rock.

At Castle Espie, near Comber, near the head of Lough Strangford, Mr. Doyle found, beside the limestone quarry (in Yellow Sandstone), a number of large boulders which had lately been stripped by the quarrymen of the drift by which they had been covered. These boulders were still undisturbed, and their upper surfaces were all scored in one and the same direction. Mr. Doyle informs me that, to the best of his recollection and belief, that direction was about N. W. and S. E. This must give approximately the line of the rock scoring; because such striations are always parallel to those on the living rock.—Since these words were first written I have had an opportunity of visiting the place, and verifying this conclusion. I saw some large boulders of trap and grit, perhaps the very ones observed by Mr. Doyle; some of them were strongly ground on one side in the direction of their greatest length; but they had then been removed from their places. Striations, however, occur on the living rock, Yellow Sandstone, at two quarries, one lying S. W. and the other S. E. of the limestone one, and each about a furlong distant therefrom; also at a short distance N. W. of Tullynakill Church; also, on Silurian rock, close to the highroad from Comber to Killyleagh, at 1½ and (in two separate places), about 2¼ miles from Comber. These instances show that, for that neighbourhood, the direction of the glacial movement was from N. W. by W. (At the quarry lying S. W. of the limestone one, besides the normal undeflected striations, there are others W. by S., but not cross striations. The grinding stream was compelled to move thus, for several yards, along the steep side of an abrupt and straight ridge of the rock.)

Within the distance of a dozen miles, however, we find an interesting difference in the run of the scorings. Striated rock appears on the

south side of Belfast Lough, on Silurian slates and grits, at Bangor, on the railway, about a quarter of a mile from the station; also on the N. E. side of the town; also at the S. W. corner of Ballyholm Bay (where the rock has been covered by water-deposited clay); also just one mile due east of Groomsport, on each side of a short lane leading southward from the road to a farmhouse—a good example both as to preservation and extent; also at a small quarry near the road, three-eighths of a mile N. N. W. of Donaghadee. These show that, for that district, the glacial movement was from about N. 5° E., agreeing pretty well with what Mr. Campbell[27] found not far off, on the hill near Clandeboye, on the summit of which Helen's Tower stands, N. E. by N. One of the instances near Bangor rather seemed as if the grinding agent had gone the opposite way; but this, I believe, cannot have been the case. M. Agassiz[28] found rock scoring at Donaghadee (and near Virginia, Cavan; and near Florence Court, Enniskillen), in 1840; but he has not recorded its direction. The explanation of the change in the lines of glaciation in that neighbourhood seems to be this—that the glacial stream from N. N. W. was there curving into the wake of the Antrim hills, which end abruptly along the north side of Belfast Lough.

We may take this opportunity of observing that the long, narrow peninsula or tongue of land, Island Magee, just north of the entrance of Belfast Lough, should have been marked on the map with a ridge-stroke, if there had been space to do so. That peninsula is a ridge parallel to the others above-mentioned in Antrim, and it is, moreover, divided into subordinate ones. Its northward end, narrow as it is, is cut by three parallel longitudinal valleys into four longitudinal ridges. But the country about the head of Lough Strangford seems to have no parallel shaping at all. The ground is very uneven, being for the most part moulded into low, roundish hills; but these have no tendency to a common direction strongly enough marked to be perceptible.

The other striations marked in that part of the country were seen by myself—on the hard chalk at the large quarry at Magheralin, near Lurgan, and on Silurian rock in the following places, viz.—At a quarry, about half a mile S. E. of Tánderagee; by the schoolhouse at Tyrone's Ditches, two miles S. W. of Poyntzpass; about a mile and a half W. by N. of Gerrard's Pass, beside a new road; on the north side of Carlingford Lough, at a cutting on the road, about a quarter of mile N. W. of Ballyedmond entrance gate; and beside the railway, a couple of miles westward of Castleblayney, in Monaghan.

The carriage of loose materials in Donegal, described by Mr. Harte,[6] evidently belongs to the district glaciation of that region, and *may* be, therefore, of somewhat later date than the phenomena just mentioned; the same may be the case with the rock grinding, &c. seen by myself about Innishowen. We shall now describe the latter. In a quarry

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[27] "Frost and Fire," vol. ii., p. 61. [28] "Ed. N. Ph. Journ.," vol. xxxiii., 1842.

beside the railway, at a short distance S. W. of Culmore station, on the Derry side of the river, the nearly vertical beds of mica slate have their upper edges broken and bent over in a remarkable manner, in a direction pointing down the river.[29] This is visible, for a great many yards, all along the brow of the quarry wall or cliff. The ground rises above the quarry, but very slightly; it is utterly impossible that the phenomenon can have been produced by the "weight of the hill." Although no striations be visible, I have ventured to put an arrow at the place. No agency seems suitable to produce such an effect but that of ice, of which we have evident traces near Greencastle. A little outside or beyond that town some mica-slate rock may be seen on the shore, which has been well ground from S. W., in a direction nearly parallel to the shore, and to the strike of the beds. No striations have survived; but, as the case is so clear, I have put an arrow at the place. These are the only two instances in which I have taken this liberty. About a mile and a half N. by E. of Greencastle, and some way up the hill, a well fluted and striated face of rock has been exposed by a stream having cut down to it through its detrital covering. The ice seems to have been mounting obliquely over the hill. On the upper part of the hill may be found what I have no doubt is glacially rounded and smoothed mica-slate, from which, however, the weather has removed the striation. A little north of Culdaff, a knoll of greenstone forms a striking *roche moutonnée*; though a neighbouring one, of about the same size, presents no token of glaciation now recognisable. A little north-westward of the town, striations are perfectly preserved on some slate rock. Some greenstone knolls and ridges near Grellagh crossroads have been very well rounded. About a mile southward of Malin, on the shore, there is some strikingly rounded and scored quartz-rock; and immediately below the bridge at that place a boss of greenstone forms as perfect a specimen of a striated *roche moutonnée* as I have seen; both of these must be referred to again. Well striated rock occurs just on the east of Malin, between the road and the river creek; also about a mile and a half N. by E. of the town, by the roadside, some way up the hill. The little hill of quartz-rock, 226 feet high, near Ballyhillian, on which Malin signal tower stands, is greatly ice-shorn from S. E., the striations being still distinctly visible in two places. Striations have been preserved on the inland slope of the highest part of the cliffs near Malin Head. It is abundantly evident that the ice moved from S. E., along the promontory of Malin, and so off the most northern point of Ireland.

The above-mentioned parallel boulder-clay ridges, north and north-

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[29] Mr. Wynne records a similar phenomenon, near Milltown Castle, about three miles south-west of Charleville, county of Cork, which he ascribes to the action of the drift (Ex. Sheet 164, p. 16). The same thing may be seen on the Drogheda Railway, in the cutting at Killester, between Dublin and Raheny. In all these cases the direction in which the upper edges of the beds have been forced over corresponds to that of the glacial movement, as otherwise evidenced in the respective neighbourhoods.

east of Ballyshannon (on the River Erne), stand upon Carboniferous limestone; but those of them that I examined are almost entirely composed of gneissose materials, which have come from the eastward. It was exceedingly striking to stand upon one of these, three and a half miles north-east of Ballyshannon, and just about 100 feet in height, and look at its native gneiss hills across the intervening low ground of bare and scantily covered limestone. I could not find a single piece of limestone about the upper part of this ridge, although, measuring in the direction of its axis, it stands two and a half miles within the boundary of the limestone, and at least one mile from the nearest part of that boundary. In going westward to the sea, the stones of gneiss in these ridges decrease, whilst those of limestone increase greatly in proportion, until at length these hills become chiefly composed of Carboniferous materials. The rock grinding corresponds with the movement of the boulder-clay. At a mile and a half due north of Belleek the gneiss has been ground *from* south of east; striations can be found, though they have generally disappeared. At Farrancassidy crossroads, a mile and a half south of Belleek, striations, east by south, were found at a quarry on Carboniferous sandstone. Farther on, about the head of Lough Melvin, the parallel shaping of the ground is very well marked; the ridges being apparently composed of drift. But the lithology of that neighbourhood is somewhat varied; and it would be impossible, without fuller knowledge of it than I possess, to say whether the blocks of sandstone that I saw were derived from the sandstone rock of that locality, or whether they came from the Millstone-grit country lying towards the south-east. A good deal of well-preserved glaciation on Carboniferous limestone has been exposed along the railway, between Belleek and Ballyshannon, and some between the latter place and Bundoran. This often shows clearly that the grinding movement was *from* about east by south. Two miles eastward of Ballyshannon, an even horizontal sheet of dolomite has been uncovered, about fifty-two yards long, with a mean width of nearly four yards. It is polished and striated from end to end, and from side to side, in the most beautiful manner; the scorings being for yards as straight as if done with a ruler; cross striations from about E. N. E. are well shown in places. The play of the sunshine on the smooth striated surface reminded one of that on fibrous gypsum. This piece of rock is worth going many miles to see.

Near Enniskillen, as I am informed by Mr. Scott, the drift is generally of local character. That place being, from its situation, not well calculated to decide the particular question that I had in view when going to Ballyshannon, it was not my intention to stop there; but, being compelled to do so for a short time, I of course made as much use of the opportunity as possible. What little I saw seemed to be in accordance with the above statement. I found some striated limestone covered with quite angular *debris* which could not be called boulder clay. The striations are probably cross ones; but, as they may not be so, they are inserted in the map. At one place on the N. W. side of the

town, where the road was being altered, beside a lough whose flooding sometimes occasioned inconvenience, a good section had just been made in limestone boulder-clay; and in the upper part of this, which was of a somewhat different colour from the lower, there were two good-sized lumps of micaceous schist still remaining imbedded in the bank. These must have travelled fifteen miles, at least, from the N. W. It would, however, be very rash to build anything upon this fact without further evidence.

The pieces of coal and sandstone found in the drift on the limestone ground near Belturbet, Killeshandra, and Mohill, *i. e.* in Middle Cavan and South Leitrim, have come, as Sir R. Griffith observes, from the north-westward.[30] Not far from the last-mentioned place, and near the north end of Lough Ree, Mr. Foot[31] has traced the course of a travelled block of jasper rock by discovering its native bed six miles off towards the N. W., near the top of Slieve Baun. The striations marked in Leitrim and Longford, which were found by Mr. Foot, do not show clearly in which direction the grinding agent moved along the lines. There can be, however, no doubt on the matter.

Following the course of the stream to the S. E. by the ridging, as marked on the map, we find limestone drift, partly, to all appearance, boulder-clay, and partly stratified gravel, &c., spread on the granite and Silurian ground of Dublin, Wicklow, Carlow, &c.: this doubtless has, or at least may have moved from north-westward to south-eastward. Then, as Mr. Jukes[32] informs us, "the Leinster granite sends off boulders in all directions, except the north, but chiefly towards the S. E." A considerable proportion of these boulders, as he observes, are on the surface. In North Carlow and South Kildare they lie on the stratified gravels; such do not belong to our subject. But, as was well seen during the formation of the Vartry Valley Reservoir, there are numbers of them on the east side, at least, of the mountains, well ground and striated, and buried in the unstratified drift. In accordance with the drift movement, we find rock grinding about Dublin, &c., which shows clearly in some places, as Ireland's Eye, Howth, Rochestown Hill near Killiney, and Bray Head, that the glacial movement was *from* the north-westward.[33] The well-scored sheet of granite, mentioned to me by Mr. Robert Browne, in Browne's Hill demesne, two miles east of Carlow, shows that the movement was *from* N. N. W., though not so distinctly as some of the instances of glaciated rock just referred to.

It is interesting to see that this stream has divided about four miles N. E. of Maynooth, evidently in consequence of the resistance of the Dublin Mountains.[33] This is evidenced by the ridging, as well as by the scoring. N. B.—It is perhaps more deserving of remark, because

[30] Sir R. Kane's "Industrial Resources of Ireland" (2nd ed.), p. 265.
[31] "Journal of the Royal Geological Society of Ireland," vol. i., p. 33.
[32] "Manual of Geology," p. 678.
[33] "Journal of the Royal Geological Society of Ireland," vol. i., p. 3.

more difficult of explanation, that there has been also a division some miles west of Skerries (see map). This also is evidenced by the ridging (see shaded Ordnance Inch Maps, 91 and 92), and by the accordant scoring found by myself, one mile N. W. of Balbriggan, in a lane which leads seaward from the highroad, and also on the shore, but a little way off. There is nothing to account for this in the shaping either of the dry land or of the sea bottom about that district. It is true there are some low and separate hills running westward from near Skerries; but such as they are usually quite ignored by the glacial streams, as happens, indeed, in that very neighbourhood; and even if those hills were continuous, and very much higher, they could not have produced the actual effect. An explanation suggests itself; but it will be safer to withhold it, as at present it might be thought too speculative.

To return again to South Leitrim, and its neighbourhood.—We have mentioned what appears to be sufficient evidence of a continuous stream from that district to Dublin, Wicklow, &c.; but now we shall notice the evidence for a movement thence to the coast of Sligo and Killala Bay. There has been a constant drift carriage from about Carrick-on-Shannon, (C. on map) to Killala Bay, following the course of the stream indicated by the ridges marked on the map and by the rock striations observed, in Roscommon, by Mr. Foot. Near Carrick, as Mr. Foot informs me, the boulders have moved from northward to southward (this has not been indicated on the map from want of room), whilst to the west of that the drift movement has been very different, as appears from the following facts recorded by Sir R. Griffith,[34] and described to me by Mr. John Kelly. The limestone gravel from the S. W. of Boyle has moved north-westwards on to the sandstone ridge of the Curlew Hills. The detritus from those hills has been carried over the limestone valley lying N. W. of them. (This is confirmed by some observations of Mr. Foot, west of Lough Arrow.) That detritus has moved onwards still, along with the limestone materials of that valley, on to the Ox Mountains, lying farther N. W. And, lastly, the Ox Mountains have sent their blocks of granite and metamorphic rock still in the same direction, over the limestone country beyond them, as far as the coast of Sligo, and also into Erris, in Mayo. The Rev. Cæsar Otway[35] mentions a granite block near Ballycastle, "fully as large as a poor man's cabin;" this is at least twenty-one miles from its native place. As I can testify myself, the quantity of these blocks seen in going from Pontoon Bridge, Lough Conn (where the boundary of the granite is), over the limestone country by Ballina to Dromore, is very great. They have been, in places, extensively removed from the land, and used to make fences; in other places, they have been covered by bog. It is true that they frequently look like *surface blocks*, which might have been dropped by floating ice. But this is partly

[34] "British Association Report," 1843, Sections, p. 40.
[35] "Sketches in Erris and Tyrawly," p. 249.

because, whilst being of large size, they often rest on rock which has only a small depth of drift covering it, partly because the buried ones are invisible! But the general facts now mentioned, as also some to be described presently, prove that we are now following the movement of the boulder-clay. The magnificent striation found by Mr. Foot at Moygara, on the west side of Lough Gara, is indicated by the *arrow* pointing W. N. W.

Looking eastwards to the neighbourhood of Ballysadare Bay, we find that the glacial movement has there been outwards, toward the N. W. This partly appears from the way in which the metamorphic blocks have gone from the hills there, which form the end of the Ox Mountains, also from the fact that the deep collection of boulder-clay of limestone materials, at Collooney, has approached those hills from the S. E., and that some of it has gone some way on over the gneiss ground. Besides this, those hills have been magnificently ground from that direction, up to the height of the summit that I visited, 651 feet, and no doubt much higher. Striations, however, have survived only in places suited for preserving them. Still many instances may be found; the mean direction being towards N. W. ½ W.

If one might presume to judge from rather insufficient opportunities of observation, the drift from Sligo to Drumahaire seems to be generally of very local character. Some boulder clay just below Sligo, in limestone ground, consists chiefly of limestone materials, with a small proportion of gneiss stones, which have most probably come from the S. E.; though a little metamorphic rock is exposed not far off in the opposite direction. The rock grinding has evidently been from the S. E., as is seen by the rounding of the metamorphic rock a little north of Drumahaire, and by the scoring of some a mile or more N. W. of Ballintogher. Slieve Da-Ean has been well ground on its inland side.

We now return to Killala Bay, to proceed thence southwards. At Ballina, which is six or seven miles N. W. of the nearest granite, the true boulder-clay, while containing of course principally blocks of limestone, the rock of the neighbourhood, contains also many lumps of granite and mica slate well buried in it; showing that the above-mentioned granite boulders are not confined to the surface of the drift. Mr. Kelly informs me that none of these boulders have gone southward; and Mr. Westropp, on a particular occasion, could not find a single one on the mica slate ground a little north of Castlebar, close to, and south of the granite rock.

The sandstone drift, boulder-clay, which covers such an extent of the limestone ground S. W. of Castlebar, has evidently come from the sandstone area lying south of it (want of room prevents this being indicated on the map), although there is also sandstone ground towards the N. W. (Since these words were first written Mr. Kinahan has confirmed this.) Corroborative of this is the movement, described by Mr. Birmingham,[36] of the stuff of the sandstone hills of Slieve Dart, near Dunmore,

[36] "Journal of the Geological Society of Dublin," vol. viii., p. 31.

county of Galway, and of a felstone dyke near their N. E. extremity. The southward sides of those hills have been swept pretty clear of drift, whilst a deep collection of it has been left lying under their lee, or northward sides. Mr. Kinahan informs me, with respect to this, that these sandstone materials have been carried to Corbally (on limestone ground), which lies about five miles N. W. of the nearest part of the sandstone area.

The rock grinding in the neighbourhood now in question confirms the evidence of the drift carriage. Mr. Westropp, Mr. Kinahan, and myself can testify that the scored mica-slate and red sandstone, a mile and a half and farther northward of Castlebar, and the granite at Pontoon Bridge, Lough Conn, have been unquestionably ground from the southward. Mr. Kinahan considers that the rocks about the head of Lough Mask have likewise been ground from that direction. It is quite clear, then, that the ice moved from Lough Mask (M.) towards Killala Bay.

But what is the meaning of the great collection of sandstone drift on the limestone ground all about the head of Clew Bay? This is boulder-clay, and all disposed in ridges, which have a decided general correspondence in direction, and which, near Newport, are very straight and parallel. It might seem, at first, most reasonable to think that that drift came from the sandstone ground above the head of the bay; especially as Sir R. Griffith supposed that the ridges were formed by some stream that flowed out of the bay. But I believe that a careful consideration of the course of those ridges, as shown so well in Bald's Map of Mayo, makes it more probable that they are the traces of a stream which flowed in from the westward, and turned to the left, joining the northward-flowing stream from Lough Mask to Killala Bay. Any one standing on the magnificent scored *roches moutonnées* of metamorphic rock, two miles east of Westport, and judging merely from them, would naturally conclude that part of the latter stream was there turning westward to flow out of Clew Bay; but, instead of this, it seems to have crossed the head of the bay, as we gather not only from the direction of the ridging, but also from the striations (N. 17° W.) to be seen on some sandstone conglomerate, near a road, only three miles east by south of Newport. If this be so, it is most probable that the ridges at the head of the bay were formed by an inward-flowing stream, which turned to the left, and joined that which moved across the head of the bay. The sandstone drift, above-mentioned, presents no difficulty in the way of this, since sandstone occurs on both sides of the mouth of the bay and on Clare Island, and, no doubt, extends across beneath the water. It would require a map of a very much larger scale than that accompanying this paper to show properly the phenomena about the head of Clew Bay.

The copious information that we possess concerning the glaciation of the country near the head and on the sides of Galway Bay chiefly serves, at present, to prove the great complexity of the subject. This complexity arises, no doubt, partly from the existence of the hills in that district, partly from the proximity of the mountains of Joyce's

Country and Connemara, and partly, perhaps, from another circumstance which will appear hereafter.

Professor King, who kindly showed me some of the glaciated rock in that vicinity, has long since observed that there was, at one time, a great glacial movement out of Galway Bay; though he has also noticed particulars which have another (but not incompatible) meaning. Messrs. Campbell,[37] Ormsby,[38] and Kinahan describe facts (some of which I have seen myself) which give evidence of an outward movement from the north-eastward, or rather from north-north-eastward, on the north side of the bay. But there are other facts in the neighbourhood which appear to speak differently. Mr. Birmingham[39] believed that the striated rocks apparently somewhere above the head of the bay (perhaps, however, near Cong), were ground from the S. W., that is, from seaward. It is unquestionable that in the *open* valley which runs westward from Oughterard, giving passage to the highroad to Clifden, the granite has been ground from west to east. The summits of the hills on each side of this valley only reach heights of about 1000 feet. Still, as Mr. Kinahan points out, notwithstanding the small elevations of those hills, this movement may have been that of the ice moving down from them, and therefore quite local. There is some glaciated limestone exposed beside the railway, within half a mile east of Athenry station, which, I am convinced, proves that the grinding agent moved at that place from W. N. W., that is, from seaward. Some small bits of granite may be found well buried in the boulder-clay at Ross Hill, about a mile and a half east of the granite rock. Therefore the district about Galway Bay of itself affords some reason for conjecturing that the scoring agent may possibly have moved at one time into the bay from seaward, although at another time it has gone in the opposite direction. The huge blocks of granite which have gone eastward to the vicinity of Oranmore, &c., may prove nothing to our present purpose; as we shall see presently, they seem not to belong to our subject. The striations, marked on the map in that neighbourhood, are only given as specimens.

We proceed to Gort, in South Galway, and to the region lying S. W. thereof in Clare. Here there is abundant evidence, as Mr. Kinahan shows, that the boulder-clay has been carried south-westwards. I myself saw in the drift near Clare station, three or four miles below Ennis, on limestone ground, a considerable proportion of sandstone detritus which must have come from the N. E. The limestone drift which, according to Mr. Foot,[40] has been carried on to the Coal-measures, in that county, must have moved in a similar direction. A great deal of glaciated rock has been found by Mr. Kinahan in the neighbourhood of Gort, and among the Slieve Aughta Mountains.[41]

[37] "Frost and Fire," vol. ii., ch. 29.

[38] "Journal of the Royal Geological Society of Ireland," vol. i., p. 18. The striations on Arranmore Island, in Galway Bay, were furnished to me by Mr. Kinahan.

[39] "Journal of the Geological Society of Dublin," vol. viii., p. 35.

[40] Ex. Sheet 131, &c., p. 20.

[41] Ex. Sheet 115, &c., p. 27.

Neglecting the cross striations, for the reasons above given, and also those in the valleys among the hills, which cannot prove anything to our present purpose, the line of the rock striation is parallel to that of the drift-carriage and the drift-ridges which are so well developed in that district. But it so happened that the instances of rock-grinding that I saw near Gort were not well calculated to show in which direction the grinding agent moved along the lines. I confess I was inclined to think that one face of scored rock exposed by the side of the railway, about a mile and a half from Gort towards Ennis, was ground from S. W. to N. E.; but the drift-carriage, I presume, proves this to be impossible. The stream with which we are now engaged seems to have flowed from about five miles, S. W. of Loughrea (L.) towards the S. W., and so off the present coast of Clare, sending a branch (as we shall see presently), across the Shannon, towards the south.

A little eastward of Loughrea, Mr. Kinahan[10] finds the boulder-clay in ridges, which have a general east-and-west bearing. (There is, however, a curious local change near Lambert Lodge.) In the same vicinity the sandstone drift has moved eastwards on to the limestone; some of the sandstone blocks have gone eastward "for miles."

As we approach Roscrea (R.), the ridges, rock-scorings, and drift-movement all have a general direction of N. W. and S. E., as Mr. Wynne[42] declares. The drift-carriage was from the former towards the latter point, as is shown by the facts, that the blocks of a peculiar Silurian conglomerate on Knockshigowna Hill have only gone S. E., and that the limestone drift has been carried south-eastwards into the mountain glens near Roscrea opening towards the N. W., and also[43] on to the Silurian ground near Moneygall. I myself found some instances of scored sandstone on the hill just S. W. of Roscrea, which showed that the grinding agent had moved from the north-westward. Farther on, the summit of the Devil's Bit, near Templemore, was found by Mr. Wynne to be scored from north-by-west to south-by-east.[44]

We meet with a slight difficulty here. The lines on the map in Clare, South Galway, and North Tipperary, if we regard only their strike, would seem to form one connected curve, running either from Dromore, by Gort, Loughrea, and Portumna, to Roscrea and beyond it, or the reverse way. But it cannot be really a single curve; for then the drift movement in Clare and that in the neighbourhood of Roscrea would give incompatible testimony as to the direction in which the stream flowed along it. The seeming continuity must be, therefore, only delusive; and the streams must have moved each way, whether contemporaneously or not, from the neighbourhood of Loughrea, where an interval occurs; the scale of the map is too small to show this interval. Those streams were flowing along the flanks of the Slieve Aughta group (south of L.), though in opposite directions; and this,

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[42] Ex. Sheet 126, p. 13. [43] Ex. Sheet 135, p. 31.
[44] Ex. Sheet 135, p. 26.

no doubt, is the reason why, near Loughrea, their tracks look so much as if they were in continuation with each other.

The east and west striations near Ross, and also near Kilcredane Point, on the north side of the Shannon's mouth, were seen by Mr. Foot.[45]

In Limerick, near Pallaskenry, the unshaded maps give manifest tokens of parallel ridging running north-by-west, and south-by-east, which is, moreover, described by Mr. Kinahan.[13] In connexion with this we must note that on the opposite side of the Shannon, partly described by the same observer.[46] On Knockfeerna Hill, near Ballingarry, striations were found by Messrs. Kinahan and O'Kelly, north and south;[47] near Pallasgrean, by Mr. O'Kelly, also north and south;[48] and near Cappamore, by Mr. Wynne, N. W. and S. E.[49] Near Charleville, in North Cork, Mr. Wynne reports a drift carriage from north to south.[50] Near Milltown Castle, about three miles S. W. of Charleville, he found some vertical Coal-Measure beds whose upper edges have been bent over towards the south; to these we have already referred.[39]

Here, then, seems to be sufficient evidence that (as above remarked) the great stream in Clare, which flowed towards the S. W., sent off a branch at about ten miles S. E. of Ennis, across the Shannon, into Limerick and North Cork, by Pallaskenry, Ballingarry, and Charleville.

We pass now to Kerry, and West Cork. The extensively and magnificently exhibited glaciation of that district deserves to be thoroughly worked out, and to have a monograph to itself. It is possible that the now-visible ice work there is somewhat later in date than that of the central plain of Ireland. But it would be assuming quite too much to exclude it from our subject; we shall, therefore, notice some leading particulars respecting it. The obtrusive signs of numerous distinct local glaciers contained in the mountain glens and corries are clearly outside of our subject; they could not have been produced (generally speaking, at least), until after the cessation of the operations which we are now considering; we must, therefore, pass by the evidence even of the "noble" glaciers (to use Professor Tyndall's word respecting them[51]) which have descended from the Reeks near Killarney.

At Kenmare we find ourselves in the track of a great stream which has flowed from above that town, probably from the neighbourhood of Kilgarvan, down the whole length of the valley estuary called Kenmare River, a distance of more than thirty miles. It has left, on both sides of the estuary, extensive traces of its passage, in rock-rounding and scoring, which have been observed by many persons, including myself. (It was the work of *this* stream on the rocks at Darrynane Bay which excited the admiration of Sir R. Murchison and M. De Verneuil.[52])

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[45] Ex. Sheet 140, p. 16.
[46] Ex. Sheet 143, p. 5.
[47] Ex. Sheet 153, p. 28.
[48] Ex. Sheet 154, p. 25.
[49] Ex. Sheet 144, p. 16.
[50] Ex. Sheet 164, p. 20.
[51] "On Heat," p. 196 (2nd ed.).
[52] "Russia," vol. i., p. 549.

But on going from Kenmare, up this same valley along the course of the Roughty River to a little above Kilgarvan, we begin to suspect, what soon proves to be certainly the case, that the stream has there flowed *up* the valley to where it turns near Morley's Bridge, and then by the valley of the Loo River, down Glenflesk, towards Headford. The evidence for this is unquestionable; it is, I confess, the reverse of what I had expected to find. The glaciation is very striking in many parts of the course now indicated, especially about the junction of the Loo and Clydagh valleys with Glenflesk. The stream which moved down Kenmare River received a tributary from the Sneem basin, of which we have ample proof in the rounded and scored rocks near Sneem, and northward of it. But some, at least, of the ice of that basin came across the mountain ridge at its head from the upper part of Glencar. The evidence for this is unmistakeable. Rock-scoring was found by Mr. Wynne[53], above the hollow containing Lough Coomanassig. That little lough is 1500 feet above the sea; it is contained in a rock basin, the lower side or lip of which is greatly rounded away. It is very probable that that rock basin was scooped by a small local glacier which formed the moraine mass which dams in the Eagle's Lough, 500 feet below. But the glaciation which can be traced to a considerable height above Lough Coomanassig cannot have been the work of that local glacier; it must have been wrought by ice which came from the north into the hollow containing the lough. This becomes very evident on proceeding eastwards to the saddle (over Lough Coomnacronia) which connects the summit, 2085 feet, with the top of Coomeenthna Mountain, 2186 feet. This saddle, or col, is slightly more than 1900 feet above the sea; it runs nearly east and west, and the rocks thereupon have been ground and scored from north to south, showing clearly that the ice has moved from the upper part of Glencar, southward over the bounding mountain ridge into the Sneem basin. That part of the ridge which connects Coomeenthna Mountain[54] with Beoun is greatly glaciated, doubtless in a transverse direction, but I had not an opportunity of walking along it. We cannot, however, conclude that the promontory between Dingle Bay and Kenmare River was once glaciated from north to south, because we find its backbone to be so; for in the lower part of Glencar we have clear evidence, some of which has been described by Mr. Wynne,[55] that the ice was there moving down that wide but well-defined basin, towards the north, *past* the western group of Macgillicuddy's Reeks. The axes or areas of dispersion in a largely-developed *district* ice-system will not necessarily coincide with lines, &c. of watershed. Still the fact that the above-mentioned saddle, 1900 feet high, has been swept transversely from north to south seems to be not without significance, when taken in connexion with what follows.

Messrs. Jukes[56] and Du Noyer[57] mention the fact, that over all the

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[53] Ex. Sheet 182, &c., p. 15.
[54] Named on the Ordnance Maps Finnaragh.
[55] Ex. Sheet 182, &c., p. 16.
[56] Ex. Sheet 192, &c., p. 46.
[57] "Geologist," July 1862.

country between the neighbourhood of Kenmare and the south coast of Cork there are traces of a general glacial movement from about N. N. W. to S. S. E., besides the marks of the local glaciers in the promontory separating Kenmare River and Bantry Bay. I have had opportunity of observing this myself. In the vicinity of Tullagha National School, which is 3½ miles S. E. of Kenmare, at an elevation of about 200 feet, and thence along the valley which carries the road to Glengariff, we find scorings in several places, which unquestionably run *up* the valley. The striations run up the steep rocks near the north end of the tunnel, and across the col, 1100 feet, and then, as may be seen in many places, down Glengariff to the shore of the bay, and, as I am informed, into the very water in some places. The scoring agent has, therefore, ascended at least 900 feet in 3¾ miles, and descended more than 1100 feet in 3 miles horizontal. The ice has crossed the saddle (about 1480 feet high) traversed by the Priest's Leap road; as is evident from the ground rock thereabouts. The well-glaciated rocks near the road, three-quarters of a mile northward of the saddle, and 500 feet below it, have been scored from below upwards. In many places, along the high east and west ridge connecting this saddle and that pierced by the tunnel, striations are well shown running across from north by west; *e. g.* on the summit of Barrabwee, 1519 feet, on that of Esk, 1273 feet, and all about the top of the eminence next to the tunnel on the east, 1393 feet. The last-mentioned spot affords as striking an example of glaciation as I have ever seen. Its traces in many places between Glengariff and Bantry show that the ice flow moved on across the head of Bantry Bay. It forced a branch *up* Snave Creek (the most north-easterly point of Bantry Bay), towards N. E. by E., the deflection being doubtless quite local. Some Carboniferous Slate, three-quarters of a mile north of Bantry, and a little south of Dunnamark Bridge, is strongly ground from west to east, against the general slope of the ground. Between Bantry and Carrickboy the glacial lines, less frequently visible, seem to have a general tendency towards S. S. E. The promontory terminating in Mizen Head is wonderfully ice-ground from side to side. At the root of the promontory the general run of the striations is towards S. S. E.; about the middle towards S.; and near the end, about Goleen and Barley Cove, towards S. S. W. Its marks show that the scoring agent has moved up-hill on one side of the Mount Gabriel ridge, and down-hill on the other; we are not left to conclude this from the scorings across the crest of the ridge. The most elevated striations that I found on Mount Gabriel—and *these* have been very well preserved—are at the height of fully 1200 feet; and we cannot doubt the correctness of Mr. Du Noyer's suspicion that the summit of that hill, 1339 feet, has been glaciated. The ice work on Knockaphuca, 782 feet, a little beyond the middle of the promontory, is very striking, and well-deserves description; the scorings on the summit run from north by east. We have passed by the long, high, and narrow promontory which terminates in Muntervary, or Sheep's Head; unfortunately I was unsuccessful in my attempt to get to it across Dunmanus Bay; but, to

judge by its appearance through a glass from the opposite side of the bay, it has been well glaciated; and, to conclude from the facts now described, the direction of the glaciation must have been transverse to the axis of the promontory. All about Dunmanway, county of Cork, the glacial markings were seen by Mr. Du Noyer[58] to run from N. N. W. to S. S. E.

The glaciation in the Dingle promontory (described partly by Mr. J. Ball in our "Journal," vol. iv., p. 151, and by Mr. Du Noyer, in the Explanations for that district) is very interesting and very well displayed; but most of that which I had the opportunity of observing seems to be of more local character, though some of it evidently takes rank with that just described; *e. g.* the great glacier which apparently filled and flowed out of the Brandon Bay valley, before the existence of the numerous distinct corrie glaciers which slid down into that valley, and have left their terminal moraines behind them.

In Waterford, on the east of the Commeragh Mountains, Mr. Du Noyer found the general direction of the striations to be the same as in Cork, viz., from N. N. W. Those mountains had their local glaciation, as he has recorded, but the striations now mentioned cannot belong thereto. The limestone drift found by him on Old Red Sandstone, S. and S. W. of Clonmel, and on Silurian ground near Rathgormuck, has moved in a direction corresponding with that of the striations. The scorings northward of Portlaw run about north and south.[59]

The scorings observed by Mr. Westropp on Yellow Sandstone, near Kiltorcan, about fifteen miles south of Kilkenny, correspond with those in Waterford and Carlow; their direction being N. N. W. and S. S. E.

It thus appears that there is, everywhere, a very strongly marked agreement, as to direction, between the drift-movement, the rock-striations, and the parallel boulder-clay ridges, wherever these last have been developed.

Independently transported materials.—But there are extensively transported rock materials, the direction of whose movement has no relation to the lines on the map. It is necessary to mention these now, although they do not belong to our subject, in order to show the distinction between them and the drifted matter with which we are concerned, and also for another reason which will appear presently.

The dispersion of the boulders of the easily-recognised granite on the north side of Galway Bay, described by Mr. Jukes,[60] and in the Explanations of many of the sheets of the Geological Survey Maps, is a prominent instance of transportation in many different directions from the same origin. Of the large boulders and small fragments of that material found by Mr. O'Kelly,[61] near Mountrath, Queen's County, 70 miles east by south of the granite district, some may possibly have been carried

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[58] Ex. Sheet 193, p. 18. [59] Ex. Sheet 167, &c., pp. 16, 80.

[60] "Manual of Geology," p. 678.

[61] Ex. Sheet 127, p. 26. I myself found in the esker at Maryborough, about ten miles farther on, a piece of granite from the same source.

thither in a curve corresponding with the lines on the map, borne by the agent that produced the ridges and striations—this, however, seems very improbable. But a great number have been carried over all the country lying not only east but south of the granite, as far as Mallow, in Cork, a distance of about 100 miles in a straight line; and it has lately been ascertained that they have gone considerably farther in the same direction. They occur on the limestone Islands of Arran, outside Galway Bay.[62] Now, to instance those in East Limerick,[63]—if these have travelled thither by a tolerably direct route, they have crossed, at about right angles, the very well marked lines in Clare. But their course, whether straight or tortuous, can have no possible connexion with the lines on the map. The same seems to be true of nearly all these *far*-transported blocks. But, on examination, we find in this no cause of perplexity. Such blocks, as Mr. Jukes states, and as Mr. O'Kelly, and also Mr. Kinahan, have separately informed me, are chiefly on the surface, and not buried in the drift. They are sometimes found in places where the boulder clay is of very local character, and also where there is little or none of it. They have even been found by Messrs. Foot and Kinahan,[64] of large size, lying on the sides of eskers, which are unquestionably later than that formation.[65] Mr. Birmingham[66] observed that the large blocks of granite about the south side of Galway Bay, which he saw had moved across the course taken by the limestone drift, and so across the direction of the rock striations, always rested on the surface of the drift. It is plain, then, that the transportation of these boulders is outside of our subject. They must have been dropped by floating ice during the submergence of the country beneath the sea, when the stratified drift and eskers were formed, and after the time of the production of the drumlins and the rock striations.

There must be many other instances, in Ireland, of similar dispersion; but, in order that such should be conspicuous and unquestionable, it is, of course, necessary that the material be peculiar, readily distinguishable, and derived from a single and somewhat limited, but not too limited area. Therefore the only other remarkable instance that we as yet know of is that of the hardened chalk and chalk flints, with sometimes pieces of mulatto stone, from the greensand, all belonging to Antrim and its neighbourhood. There are numbers of chalk flints on the shore at Ballyhillian, near Malin Head, Innishowen. They occur, as Mr. Jukes states,[67] all along the eastern and southern coast of Ireland, at least as far as Ballycotton Bay, Cork. Near Dublin they are to be found on the Three Rock Mountain, at the height of at least 1200 feet, in water-arranged gravel. These Antrim materials have been found at

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[62] Murray's "Handbook for Ireland," p. 173.

[63] Ex. Sheet 144, p. 34. [64] Ex. Sheet 115, &c., p. 34.

[65] Large blocks of Wicklow granite may be seen lying on an esker three miles south-west of Baltinglass, which is on the *west* side of the Wicklow Mountains.

[66] "Journal of the Geological Society of Dublin," vol. viii., p. 30.

[67] "Manual of Geology," p. 675.

Nenagh and Clonmel, by Messrs. Oldham[68] and Du Noyer;[69] in the Isle of Man, by Mr. Cumming;[70] in North Wales, by Messrs. Trimmer[71] and Trevelyan, at elevations of 1000 feet, along with Irish calp, and probably-Irish granite. The flints and *hard* chalk found near Bridgenorth, in Shropshire, by Mr. Maw,[72] seem to have had the same origin; to which we might perhaps add the flints and chalk found near Warwick by Mr. Brodie.[73] The transportation of rock material in the N. E. described by Mr. Bryce, as above mentioned, evidently belongs, *in part*, to this section.

Of course, we are not to suppose that such transported materials, carried as they must have been by floating ice, moved away from their respective origins, in so many different directions, necessarily along straight lines. They doubtless often drifted about to and fro, under the influence of tides and winds, for some time before they were dropped from their ice rafts.[74]

Depth of the grinding agent.—We must wait for fuller evidence before we can speak positively as to the greatest height at which the marks of the general glaciation can be found in Ireland; and even when this shall have been determined, it will not necessarily enable us to fix the limit of the depth of the ice.

The most elevated spot that we know of, at present, where the actual glaciated rock surface still survives, is the summit of Ben Gowar, one of the Twelve Bins, in Connemara, which is 2184 feet above the sea. Mr. Kinahan has found the rocks there well rounded and smoothed, though the striations have not been preserved. Mr. Campbell had previously noticed that Shannaunnafeolagh, 2012 feet, which forms the south-easterly end of the Maum Mountains, Connemara, is ice-ground on its summit. I am enabled to confirm this from my own experience. The rocks on the summit are well worn (and very strikingly so lower down), and three instances of surviving striation were found by myself and companion on the rounded and polished vein-quartz at the very top; the mean direction being about S. W. by W. to N. E. by E., or the other way. Mr. Du Noyer was struck by the rounding of the mountains at Killarney up to 2500 and 2800 feet nearly.[75] To this we may

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68 "Journal of the Geological Society of Dublin," vol. iii., p. 66.

69 Ibid., vol. vii., p. 114.

70 "British Association Report," 1845, Sections, p. 61.

71 "Journal of the Geological Society of Dublin," vol. i., pp. 269, 291.

72 "Quarterly Journal of the Geological Society of London," 1864, p. 134.

73 "British Association Report," 1865, Sections, p. 49.

74 Sir R. Griffith (34) and General Portlock (4) long ago detected the complete want of connexion between far-travelled surface blocks and the deposits, whether boulder clay or esker drift, on which they rest. The circumstances of the dispersion of the Galway granite boulders are precisely similar to those of the *rapakivi* blocks of the Government of Viborg, for instance, as described by Durocher ("Comptes Rendus," vol. xiv., 1842, p. 93). These have been carried, as he believed, by floating ice in widely diverse directions, sometimes at right angles to that of the great drift translation and the rock striations, which he believed to be the effects of a different and previous operation.

75 Ex. Sheet 184, p. 35.

add that near Sneem, Kerry, the nearly naked tops of some of the hills, about 2200 feet in height, have evidently been rounded away by the same agent which has so extensively ground and scored the rocks a little way lower down, and on the level ground below. The striations found by Mr. Wynne,[44] running across the top of the Devil's Bit, near Templemore, are 1583 feet above the sea. Near Dublin the grinding agent was at least 1000 feet deep; but if it flowed at one time in a steady stream across the long range of the Dublin, Wicklow, and Wexford Mountains, as several considerations seem to render very probable, it must have risen then to the height of more than 2100 feet.[76]

Recapitulation as to the directions in which the streams have flowed along the lines.—It will be convenient to review concisely our conclusions respecting the movements of the streams in the west-central district, adding some corroborative considerations, before proceeding to the next section. Since the three kinds of phenomena belong decidedly to each other, as effects of a common cause, we may use their joint or separate evidence, as we have opportunity. As before observed, it frequently happens that the instances of rock-striation, while showing the line of motion, do not of themselves indicate clearly which way the ice moved along that line.

The evidently continuous stream which reached from near Carrick-on-Shannon (C.) to beyond Dublin is proved, by the drift-movement near Carrick, and the drift-movement and rock-grinding near Dublin, to have flowed from the former towards the latter place.

The evidently continuous curving flow between Carrick-on-Shannon and Killala Bay moved from the former to the latter; for the following reasons:—There has been a constant drift carriage all the way along the curve, first southward by Carrick, and then north-westward towards the north of Sligo and Killala Bay. The drumlins S. W. of Carrick are blunt at their N. E. ends; those ends, then point up stream. And, lastly, the scorings at Moygara indicated by an *arrow* on the map are from E. S. E. to W. N. W. Besides all this, the connexion between this stream and the last is such that, if we knew of either that it was coming down from the neighbourhood of Lough Allen, we could conclude that the other was doing the same.

An evidently continuous stream-track connects the south end of Lough Mask (M.) with Killala Bay. The rock grinding and the drift carriage separately prove, in the clearest manner, that the motion was from the former towards the latter place. So, then, of these two last-mentioned streams, each gives independent evidence that it was flowing towards Killala Bay. But, besides this, the connexion between them is such that, if we knew of either one only that it was flowing towards that place, we could conclude for certain that the other was so likewise.

[76] There are two blocks of granite on the Great Sugar Loaf, near Bray (Cambrian quartz rock), at the height of 1480 feet above the sea; and there are several others at 1300 feet; and near the summit of the Two Rock Mountain (granite) pieces of limestone, greenstone, and white sandstone can be found at the height of about 1760 feet. All these, however, may have been carried by floating ice.

From the neighbourhood of Loughrea (L.), in South Galway, a stream has flowed eastward and then south-eastward to Roscrea, and beyond it, as appears by the drift carriage and the rock grinding. Another stream has moved, whether contemporaneously or not, from the same neighbourhood of Loughrea south-westward into Clare, and onwards off the present coast. The direction of the movement along this stream-track is shown by the transportation of the boulder drift.

The composition of the streams,—glacier ice.—The streams whose nature we have to consider, belonged to two divisions. Those belonging to the general glaciation evidently formed a connected (though not single) system; they must have been, therefore, all of the same nature, whatever that was. But we could not assume that those which belonged to the separate radiating district systems were necessarily of the same nature as the others. It will, therefore, be necessary to examine both. We have now to seek for some agent which is capable of doing *all* that is required. One that can score rocks, for instance, will not avail us, unless it can also form parallel drumlins, and flow as the streams have flowed; and so on.

The various agencies which have been suggested as having caused the phenomena in question are the following:—

1. Violent and transient debacles of water, consisting, as some have supposed, of *waves of translation.*

2. Floating ice of different kinds (bergs and floes) carried by ordinary ocean currents, during the submergence of the country.

3. "*Mud-glaciers,*" slipping off the land as it rose out of the sea.

4. Glacier-ice, moving, under different conditions, over the country.

Some of the other theories have sometimes been supplemented by No. 2.

Of these, No. 1 is now so generally given up by geologists that it need not detain us long. Rushing water carrying along detritus is not a *vera causa* of parallel rock striation. This is notoriously the case as respects rivers, sea-waves, and tidal currents; and Mr. Jamieson[77] has satisfactorily proved it to be so for such debacles as that caused by the bursting of the Crinan Canal reservoirs. Besides, it seems quite impossible that the curves in the west-central part of Ireland can be the tracks of debacle rushes of water, even supposing these capable of parallel rock-striation. The parallel drumlins, having always the same direction as the striations near them, are, as we have seen, unquestionably connected therewith as effects of some common cause; therefore, since the striations have not been produced by the force of mere water (urging stones along), those ridges have neither been piled up, nor carved by denudation out of pre-existing deposits, by water action. Some, however, of the *irregular* mounds and ridges of boulder clay, which occur in certain places, may have been so carved, to some extent at least.

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77 "Quarterly Journal of the Geological Society of London," 1862, p. 164.

No. 2 is a far more probable theory. It is nearly certain that floating ice was moving about during the submergence; and it must often have scraped and otherwise abused the rocks when grounding on them. But that it was generally incapable of producing such striated surfaces as we have to account for seems clear, for reasons which have been already advanced by various writers, and which we shall not now repeat. We may, however, observe that the glacialists who account for the steady parallel rock-scorings by floating ice constitute two mutually destructive parties. The first have recourse to small icebergs and floes swimming in shallow water; because they are impressed with the evident truth that large ones could not sufficiently get at the surface of the ground, owing to the inequalities of it. The others choose very large icebergs, perhaps "150 miles wide, and 3000 feet deep;" because they are justly convinced that small ones grounding on the rocks, and then swinging round and moved up and down by tides, could not produce such striation as we are considering.[78]

There are cases in which it is evident, either from the position or the character of the rock-grinding, that floating ice could not have been the agent by which the general glaciation was effected. The scorings often occur in places which could not have been got at by a floating mass moving in the direction of those scorings. The down-hill striations on the lee side of Howth, one-fourth of a mile S. W. of Casana Rock, and on the lee side of Killiney Hill, near Mount Eagle House, on the opposite side of the road (a well-displayed instance, in which the scorings are oblique to the steep fall of the ground), and the striations, not down-hill, but just under the lee of a prominent ridge on Bray Head, near Ballynamuddagh farmhouse, and running nearly at right angles from that ridge, all of which belong to the general system, are situated in the way described.[33] (So likewise were those exposed below the embankment in the formation of the Vartry Valley Reservoir. These were right at the bottom of the shallow valley, and running across it; they may possibly, however, have belonged to the local glaciation of the Wicklow Mountains.) Now, the connexion of the phenomena from Dublin to Loughs Mask and Conn is such that, whatever we can prove or disprove, at any one place in the stretch of country now

[78] A most important contribution to the controversy on the present point is contained in a paper which has been published just in time to be referred to in a note. Mr. Jamieson, in his communication to the Geological Society of London ("Journal," 1866) on the Drift of Caithness, gives cogent reasons for believing that the parallel rock-scoring from N. W. to S. E., across the northern extremity of Scotland (already described by Mr. Chambers), has been wrought by sea-borne ice. The drift there looks just like true boulder-clay; but it contains marine shells, even in its lowest parts, showing that it was accumulated under marine conditions. The stones therein often exhibit striations parallel to those on the living rock. The rock-striation, therefore, seems to have been produced by the agent which formed the drift. The fact that the scorings run in upon the land, from N. W., that is from seaward, seems to Mr. Jamieson to be itself a proof that the grinding agent was not glacier-ice. Mr. Chambers, however, did not regard this fact as necessitating this conclusion ("Edinb. N. Phil. Journ.," vol. liv., 1853).

indicated, respecting the nature of the streams which have caused those phenomena, must hold good for the whole; yet there is no harm in looking for confirmation in other parts of it. Near the lower end of Lough Mask, then, and westward of Cong, striations are visible in a ditch by the roadside, which point both ways to ground higher than their own locality, and which, therefore, could not have been produced by floating ice. It is, moreover, very difficult to conceive that the magnificently rounded and scored *roches moutonnées*, two miles east of Westport, for instance, could have been the work of such apparatus. Besides, it seems quite impossible that streams moving as those have done in the west-central region could have been sea currents.

There is a striking case which proves that the rock-scoring stream from East Derry to South Down could not have consisted of water bearing floating ice. Close beside the schoolhouse at Tyrone's Ditches, in Armagh, and two miles S. W. of Poyntzpass, in the very bottom of a well-marked valley, there is a small quarry in Silurian grit, the rock exhibiting striations which are inclined at an angle of about 60° to the direction of that part of the valley. The *continuous* up-stream side of the valley is, as shown by the Ordnance Survey elevations, at least 130 feet above the scored rock (some of it more), at the distance of just half a mile horizontal. The scoring agent has, therefore, unquestionably descended 130 feet in that horizontal distance in order to reach that rock. Having passed the rock, it had to ascend again considerably to get out of the valley, but how much it is less easy to determine. In the same valley, in four places for the distance of about half a mile, along the Newry and Armagh railway, striations occur, speaking to the same effect as the others, though not so emphatically, as the railway runs along the side, and not in the bottom of the valley. It is absolutely certain that none of the striations belong to any local glaciation.

Moreover, it is very difficult to conceive by what operation floating ice could have made the drumlins. It is rather to be supposed that it would try to rake down and spread about the materials of already-existing drumlins, whenever it had the chance, even though working in the direction of their axes.

We may now remark that, since floating ice-masses have been carried about (very probably to and fro) in so many different directions, as we must conclude from the dispersion of the far-travelled surface boulders of Galway granite, and of the Antrim chalk flints, &c., if floating ice could striate the rocks to any extent in the manner we now have in view, those masses should have left a hopelessly unintelligible maze of crossing striations such as we do not find; although, as we have said, cross striations do occur.

Now with respect to the district system of Donegal. The glaciation near Malin may possibly not belong strictly to the same state of things as that just now mentioned; but it cannot have been, any more than the other, the work of floating ice. On the shore, close below the bridge at Malin, is a very fine *roche moutonnée* of greenstone. There is

an equally striking glaciated rock of quartzite, also on the shore, about three-quarters of a mile south of Malin. The smoothed and striated surface is, in both cases, in excellent preservation, apparently because the rocks have been comparatively lately stripped of drift by the action of the sea, whilst their sheltered positions have prevented the waves from destroying the ground surface. In the latter case, the grinding agent, in coming obliquely against the vertical face of a little promontory of the rock, has undercut it, at the same time scooping out at the base of the little cliff a miniature rock-basin, containing a lake about a foot long. The channel, which is undercut on the front of the promontory, is continued thus a little way along the side thereof, when it ceases to be undercut, and becomes a wide cylindrical hollow or trough, the surface of the whole being beautifully smoothed and striated. These rocks both show that the grinding agent came from about E. S. E., and that it must have had a very steady and a very long-continued motion, such as no iceberg could possibly have, unless it were of enormous dimensions. But then, no such great iceberg could have got at those rocks to grind them as they have been ground, without crossing the ridge of hills to the S. E., and then descending to the present sea level, which it could not do.

Now with respect to the district system of Kerry and West Cork. The three streams which have gone in three different directions, from the neighbourhood of Kenmare—one down the Kenmare valley, another up it, and another across the mountain ridge which separates that valley from Glengariff—could not possibly have been sea currents, whether with or without floating ice. The glaciation about Darrynane Bay has not been wrought by floating ice. Among other particulars, the stream of which it is the work (one of the three just mentioned), came down the fiord called Kenmare River, and, below Darrynane Bay, overflowed across the col traversed by the road inside the summit, 1017 feet, and moved, as its marks show, down a steep descent into Ballinskelligs Bay, which floating ice could not do. Another of those streams has flowed across several transverse hill ridges, on its way to the south coast of Cork, moving up and then down their sides to the sea level—an impossibility for floating ice.

Theory No. 3 was proposed by Mr. Mallet,[79] and has been advocated by Professors Sedgwick[80] and Haughton[81] and others. It seems to be strongest on those sides where No. 2 is weakest. It is highly probable that a mud-slide, of sufficient magnitude and permanence, might grind and score the rocks much as we find them to be ground. It could, moreover, adapt itself to the inequalities of the surface of the ground, and descend into depressions, as floating ice could not do.[82] The *mud-glacier*

79 "Journal of the Geological Society of Dublin," vol. v., p. 121.

80 Before the British Association, in 1845.

81 "Journal of the Royal Geological Society of Ireland," vol. i., p. 92.

82 Still it could not do the latter as well as glacier ice. The friction between different *couches* of a mud mass is less than that between the lowest one and an ordinary rock

and ice-glacier theories supply the same rock-grinding instruments, viz., mud, gravel, and blocks, worked by agents which, in both cases, would consist of stiff yet yielding masses, which would flow along in *somewhat* similar fashions ; it is, therefore, reasonable to imagine that the work performed by the respective apparatus would be, in some respects, similar. But then the questions arise—How deep could a mud deposit be without ceasing to be mud in the lower parts? and again, Would it be possible to have a continuous mud-slide from near Carrick-on-Shannon to beyond Bray Head, a distance of more than 100 miles? Whatever answers may be given to these questions, there is an insuperable objection to this theory, afforded by the parallel drumlins, which so indubitably belong to the same cause as the rock striations. According to the theory, the boulder-clay is what remains of the mud glaciers, but the drumlins are boulder-clay; therefore the drumlins and the streams which formed them were composed of one and the same material; which seems impossible.

Theory No. 4 still remains; and glacier-ice is able to produce the phenomena for which we seek to account; and *that* in every place where those phenomena occur. If then all conceivable explanations be excluded, in turn, except one, and that one may be true, we are forced to conclude for ourselves that it must be so. The parallel drumlins are, then, longitudinal *moraines du fond* belonging to the iceflows that once covered the country. Still it is not easy to explain the mode of formation of those ridges. In some cases a mass of rock has acted as an impediment to the stream, and so given origin to a ridge of drift; but in many cases, I believe in the great majority, there is no reason *now apparent* why a particular drumlin should stand where it does, and not in the vacant interval beside it. This difficulty, however, does not press more heavily on the present theory than on any other. The same thing often happens with the ridges of sand made by a stream of water. As before observed, the drumlins often have a marked uniformity of height in the same neighbourhood; as may be seen in Mayo, and near Ballyshannon, for instance. Brongniart[20] noticed the same thing with the above-mentioned Swedish ridges. Very probably this is in some way or other connected with the depth, or the consistence, or the rate of motion of the ice stream.

We must not omit, however, to notice a difficulty. Sometimes the true boulder-clay (as it seems to be), lying on some particular kind of rock, will contain scarcely any fragments of that rock; almost every one of the blocks and stones therein being derived from another, none of which is less than two miles off in the up-stream direction. Illustrations of this may be seen near Stillorgan, county of Dublin, where the rock is granite, and the stones limestone; near Westport (eastward of

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surface; the reverse is the case with glacier ice. Therefore, a transverse hollow strongly enough marked that a mud stream must pass over, after having filled it, might have its bottom well swept and worn by an ice stream.

it), where the rock is limestone, and the stones sandstone; and on the N. E. of Ballyshannon, where the rock is also limestone, and the stones gneiss. The same is the case with the great collection of drift which covers so much ground between Killarney and Millstreet. This, as Mr. Du Noyer[83] observed, is all composed of sandstone materials from the neighbouring mountains, though it lies upon the limestone. Much of it is evidently true boulder-clay, containing blocks of large size, often magnificently scored on one side, though some of it has been washed and stratified by water. Mr. Jukes noticed that the great mounds already mentioned, near Bantry,[16] seem to contain none of the purple slates and grits of their locality; the stones in them are composed of green slates and grits, with many limestone blocks which must have been carried from elsewhere (probably from the Kenmare valley) into that hydrographical basin. Now, if the boulder-clay be the *moraine du fond* of the universal glacier, it seems very wonderful that it could be, in certain cases, swept along sometimes for two miles and more over a particular kind of rock, without picking up more fragments of that rock. This difficulty presses equally on all the theories now mentioned, except that of floating ice. We are reminded of Mr. Geikie's[84] conclusion that the "upper boulder-clay" to be found in some places is the work of floating ice, though the lower has been formed by glacier-ice. However, I do not believe that this, though it should be correct, will explain the present difficulty as now instanced.

The mobility of the ice.—Glacier-ice, of the development that we are compelled to contemplate, must have had vastly greater mobility than might seem possible on first thoughts. This appears from several considerations, some of which may be particularized.

If two unequal, but geometrically similar, masses be composed of the same plastic material, and if the plasticity be unaffected by greater or less pressure, then the two masses will not behave similarly when left to the action of their own weights, or of forces similarly applied, and proportional to the masses. The parts of the larger will have greater capability of relative motion than the homologous parts of the smaller. This is a familiar fact, and the reason of it is obvious. Though the specific plasticity be the same in both, yet what we may call the virtual plasticity of the larger, taken as a whole, will be greater than that of the smaller in the high ratio of the squares of the initial linear dimensions of the masses. Now, in ordinary cases the specific plasticity would not be the same in both; it would be somewhat diminished in the larger mass by the greater pressure; but it appears that the reverse obtains in the case of glacier-ice.

The experiments of Professor Thomson[85] show that the freezing point of water is lowered $0^{\circ}\cdot0075$ Centigrade by every additional atmosphere of pressure. Hence, supposing the law to hold far enough, if the

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[83] Ex. Sheet 184, p. 34.
[84] "Scenery and Phys. Geol. of Scotland," pp. 300, 304.
[85] "Phil. Magazine," vol. xiv., 1857. Tyndall "On Heat," p. 108 (2nd ed.).

universal glacier were 3000 feet deep, its lower part must have been at least 1° Fahr. nearer, respectively, to its melting point than the upper, which was itself partially in a melting condition (since a glacier consists essentially of melting ice); consequently the lower part must have been rendered, by the pressure, greatly more plastic[86] than the upper, and not more rigid, as might be supposed on first thoughts.

We may note some other particulars of probably less importance. The experiments of Mr. W. Hopkins[87] show that a mass of ice will move down a slightly inclined, roughish slab of stone, more easily when loaded with a weight than when without it. Again, the universal glacier could not have been as well drained as a modern Swiss one; water must have been sometimes pent up between it and the ground in the level districts. Again, it was generally free from resistance corresponding to that which an Alpine glacier experiences from the sides of its bed.

On combining the effects of all these circumstances, by multiplication, it would appear that the mobility of the flows of the universal glacier must have been some hundreds of times greater than that of the Mer de Glace, for instance; and therefore there is no reason to doubt the possibility of such flows moving about in the manner indicated on the map.

Explanation of the movements of the ice.—It seems almost impossible to explain the movements of the various flows on any other supposition than that of their consisting of glacier-ice. But on that supposition the behaviour of the streams may be accounted for. With respect to the present question, two leading facts claim attention. The first is, that the ice has been flowing outwards from off the present land on every side of Ireland. The second is, that the preponderating direction of its movement was from about N. W. to about S. E.: one stream has flowed from East Derry, not far from the north coast (whether it started thence, or not, we do not know), towards the S. S. E., and after a course of sixty miles, at least, has left Ireland at Carlingford and Dundrum Bays, having, of course, flowed against the Mourne Mountains; another stream has moved from the low ground, a little way above the head of Galway Bay (whether it started thence, or not, is the question), and has evidently gone inland, a portion of it going right across to the S. E. corner of Ireland; while, lastly, the land at the head of Clew Bay, on the west coast, has been invaded by a stream from without.

One explanation had occurred to me when permitted to read this paper before the Society, which is as follows:—Ireland may have been

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86 The plasticity of glacier ice is a fact, whatever be the property or process of which it is the result, such as "viscosity" or "crushing and regelation," or both together. The present and a following particular in the text may account for some deposits which look like boulder drift partially and slightly washed. At Balbriggan there is a deep collection of this overlaid by esker drift; at Killiney Bay and also at Castle Espie, above mentioned, a somewhat similar deposit may be seen.

87 "British Association Report," 1843, Sections, p. 62.

at one time invaded from W. N. W. by part of the great northern ice-cap of the globe lying in that direction, which may have been separated into somewhat distinct flows by the mountain barriers of the west. (The elevation of those barriers is to be estimated in this case from the neighbouring sea *bottom*.) The flow entering about Sligo Bay would be thrown somewhat southward by the hill masses east of that; the flow entering at Galway Bay would be thrown up somewhat northward—first, because it would be curving into the wake of the West Galway mountains; and, secondly, because it would be still subject to the resistance of the Slieve Aughta group, on the other side of the bay. These two flows would meet in the plain of East Galway, and each, by its resistance, divide the other into two, and so produce the curves in the west-central region, except that running S. W. from near Loughrea. After the great movement on to Ireland from W. N. W. had ceased, the ice on the country at the time, as soon as it was free to do so, would send streams back again out of most of the western bays, which would produce the glaciation now visible in those bays, after having obliterated the marks of the former flows from without inwards.

The phenomena in Clare, however, show but little disposition to conform to this arrangement. There is another objection to this explanation, in that the materials derived from different localities in the boulder-clay of the west have not been mixed together to the extent we might expect if the ice was, at different times, going in different directions. There is another objection, and that no trifling one, arising from the great depth of the ocean bed lying to our W. N. W. This makes it very hard to believe that Ireland can have been swept by glacier-ice from that direction. Still it may be worth while to note some circumstances in mitigation of the difficulty. Some have been driven to the theory of a Miocene Atlantis, connecting Europe and America, in order to account for the relationship between the Miocene Flora of Europe and the recent Flora of *eastern* North America. Even though this relationship may be otherwise explained, still it is probable, as pointed out by Sir Charles Lyell,[88] that Greenland, Iceland, and the Hebrides (to which we might add North-east Ireland) had communication by dry land during the Miocene period. A later connexion seems hinted at by the great number of shells which range from the European to the American boreal seas; by the fact that the musk ox whose remains have been found in England belongs to the same species, *Ovibos moschatus*, which exists in, and is confined to the American continent;[89] by the fact that the remains of several individuals of the Greenland lemming have been found in England by Dr. Blackmore;[90] and, lastly, by the fact that Greenland is steadily sinking at the rate of a few feet per century,[91] which shows that it was formerly higher than it now is.

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[88] "Elements of Geology" (last ed.), p. 270.
[89] "Journal of the Geological Society of Dublin," vol. x., p. 173.
[90] Lyell's "Elements," p. 131. [91] Ibid., p. 46.

I was led to believe, at one time, that direct evidence in favour of the present explanation was to be found in a certain part of the south-west of Ireland; but on an examination of the place it appears that such is not necessarily the case. I believe that, so far, no direct evidence of the theory we are now considering has been found in Ireland; for even the phenomena at the head of Clew Bay do not supply this, as we shall see presently.

There is another explanation of the movement of the glacial flows, which seems to be a more eligible one, in that it does not involve so violent a supposition, it is simpler, and it accounts more readily for all the facts. It had not occurred to me at the time when this paper was offered to the Society, but I beg leave to submit it now. If the western side of Ireland were now to undergo some upheaval, not reaching too far northward, the dry land would, of course, as a concomitant result, extend farther out in that direction. If the alteration of relative level were sufficient, and if the region were *then* covered, say to the depth of 3000 feet, by a general glacier formed of the snow falling directly thereupon, it is highly probable that the ice, moving about under the influence of gravity, would leave on the present surface of Ireland the very traces that we find. The ice covering would constitute, in a certain sense, one whole—it would consist of different, indeed, but connected parts, which would influence each other by their mutual pressure. At its greatest development it would be, to a great extent, independent of the higher masses of ground as sources of supply; it would sometimes even chafe at them as impeding barriers; and the longer flows would necessarily be on the eastward side of the *present* area of the island.

The following are the more noticeable particulars respecting the movements of the flows; and all seem to be readily explicable on the present supposition. If the glaciation on the low ground about Galway be all contemporaneous, which is certainly the simplest view, then a line of dispersion ran *along the plain* from near Cong, at the southern end of Lough Mask (M.) to near Loughrea (L.) passing, at a short distance, within the head of Galway Bay.[92] According to this, a stream *started* from the neighbourhood of what we now call Galway Bay, but which, at the time we are considering, probably occupied a tolerably central inland position. Another has started from the hill country north of Carrick-on-Shannon, flowing south; each of these has, by its pressure, divided the other into two.[93] There is nothing whatever in

[92] Mr. Kinahan finds that north of Cong the blocks have gone northwards, and south of Cong southwards. As this line or axis of dispersion would owe its existence entirely to its situation relatively to the mass of the great glacial envelope, and had no ridge to determine its exact position, it is conceivable that it may have been somewhat unsteady, and may have changed its position a little, as inequalities occurred in the formation or waste of the general glacier. This may help to explain some of the complexity of the glacial phenomena near the head of Galway Bay.

[93] The divergence, inwards, of the ridges above the head of Galway Bay was noticed by Mr. Birmingham.

the shape of the ground to account for the division of these streams. It is true, indeed, that Slieve Baun rises to about 650 feet above the plain, at seventeen miles due south of Carrick; but it is utterly impossible that it could have divided the stream near Carrick. The right branch of that stream has turned sharply away from the wide plain before it, and flowed directly against, and across, the long, straight range of the Ox Mountains in Sligo (XX.). The right branch of the great stream from near Galway Bay has flowed from the low ground, past the Slieve Aughta group (south of L.), and directly against, and over, the range of Slieve Bloom, the Devil's Bit, and Keeper Mountains (BK.); and then evidently onwards towards the Waterford and the Wexford Mountains, passing out between them off the S. E. point of Ireland. The above-mentioned hill country, north of Carrick-on-Shannon, extending to Sligo and the Loughs Erne, has been a centre of very extensive glacial dispersion; but this seems to be much more in consequence of its position than of its altitude. The great flow which has moved thence towards the S. E. could not have belonged to the proper district-system of that hill mass; because it has, at the distance of eighty miles, split itself against the northern end of the much higher and more extensive mass of the Dublin and Wicklow Mountains, which have sent forth no such stream themselves on the west at least, although they had, as we know, their local glaciation. The stream which flowed from East Derry to South Down (where it came against the Mourne Mountains) is accounted for by the present explanation quite as well as by the other. The mutual interference of the ice of Scotland and that of Ireland would give rise to a flow along the North Channel, and parallel to it in East Derry and Down. The striations at the head of Luce Bay, and, more clearly still, those near Corsill Point, Wigtonshire,[94] seem to be related to the glacial lines parallel to them in North-east Ireland, and not to their immediate neighbours, which are divergent from the high grounds of their district, and are probably of later date. The great flow in Clare towards the S. W., which has apparently sent off a branch across the Shannon into North Cork, takes its place at once under the present explanation. The general movement in South Kerry and West Cork towards S. S. E. is in accordance therewith; so also is the inward stream at the head of Clew Bay. When we consider that the plain country runs down to the head of that *deep* or long bay, and that the sides of the bay are mountainous, it seems very probable that the inward moving stream may have only started from near the mouth of the bay, and that, outside, the ice was flowing outwards toward the west.

Some sufficient increase of relative height towards the west or W. S. W., with a corresponding extension of the land in that direction, is required, if we are to account for the general glaciation of Ireland by

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94 For these see the Glacial Map of Scotland in Mr. Geikie's book on the Scenery and Physical Geology of that country. They could not have been brought into our Map without reducing the scale too much.

the movements of an universal ice-covering formed upon her own surface.

It is interesting to note the following particulars in this connexion. To judge by the Contour Map of Ireland prepared for the Land Tenure Commissioners, the mean plane of the central plain and its ramifications in Ireland is lower at its western than at its eastern margin, by about 200 feet. Now, if that plain be one of marine denudation, as it seems most reasonable to suppose, it is also reasonable to think that its mean plane was originally about horizontal; that is to say, that the western side of what is now Ireland was then higher, as compared with the eastern, than it now is. Again, the western coast line is much more indented and irregular than the eastern; and there is no purely orographical reason why this should be so; because the mountains of Ireland are chiefly situated round the borders, and do not form a longitudinal backbone nearer to one side than the other, with a general slope and counterslope. But the 200-foot line of soundings off the west coast is similar in character to the eastern shore line. It seems to be not without significance that the same change of relative level which would bring the mean plane of the central plain into horizontality would also assimilate the western and eastern coast lines.

Again, Mr. Kinahan has concluded from quite other considerations, connected with the elevations of certain eskers, that the western side of Ireland has not risen as much as the eastern from the submergence in the glacial sea. This and the particulars just mentioned are, at least, in accordance with the notion that the present gentle slope of the mean plane towards the west may not have existed originally; that is to say, that the west of Ireland may have been once higher, relatively to the east, than it now is.

Again, Professor King[95] has suggested that the now-submerged edge of the Irish plateau probably formed the boundary of the land during the land-ice period. If this be so, the land extended about 200 miles farther westward opposite Galway Bay, though not so far elsewhere.

Therefore, we have independent reasons for conjecturing that the conditions of relative level and extent of land, required to explain the General Glaciation of Ireland, may have actually existed.

XXVIII.—On the Occurrence of Slickensides in the Trap Dykes of Arran Island, Scotland. By Henry E. Bolton, Valuation Service, Ireland.

[Read April 11, 1866.]

INTRODUCTION.

During a recent visit to the Island of Arran, in Scotland—a locality well known to geologists—I devoted a portion of my time to the exa-

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95 "Fraser's Magazine," Oct. 1863.

mination of some of the trap dykes, which are well developed along the shores of Lamlash and Brodick Bays, cutting the Old Red Sandstone in various directions, and exhibiting in themselves a varied crystalline appearance, due I think to the circumstances of solidification, rather than to original differences of chemical composition.

Atmosphere and climate are ever at work in changing the appearance of these rocks: some were completely worn away, leaving only the hardened walls of sandstone behind to mark their original position; others presented on their surfaces large and beautiful crystals of hornblende and felspar. A hand specimen of these in a museum would fail to give a correct idea of the rocks themselves—free use of the hammer alone *in situ* is required to remove the hypersthenic crust, and show that the mass is but an ordinary syenite which is weathering on the surface.

Some of these syenitic trap dykes contain zeolites; near the King's Cross Point a remarkable instance of such may be observed. At first sight the rocks present a mottled appearance, which on closer examination is found to be caused by nests of natrolite, varying from the size of peas to that of marbles.

Pitchstone dykes are very common, as at the Corrygills; sometimes the pitchstone forms intervening beds in strata of Old Red Sandstone, where it was injected from some neighbouring dyke.

Examples of trap passing into clinkstone, pitchstone, pearlstone, spherulite, claystone, &c., are also to be seen.

When pitchstone occurs as a dyke, it invariably assumes the prismatic structure common to other trap dykes whose collateral walls are parallel; but where it has been erupted through strata, and rests superincumbent thereon, its structure becomes concretionary, as at Glen Ross; the vitreous lustre and characteristic conchoidal fracture are, nevertheless, common to both.

SLICKENSIDES.

The subject of my paper for this evening—namely, Slickensides—is one that has interested both mining and physical geologists, owing to the apparent connexion of the phenomenon with mineral veins and the joints which carry them.

Various theories respecting the origin of those polished and striated appearances which frequently occur on the surfaces of rock fissures have been propounded and discussed by eminent and trustworthy geological observers. The points of controversy, however, may I think be resolved into two theories—the one assuming that Slickensides have been produced by motion between rock surfaces, and the other maintaining that the striæ and polish are the results of crystallization of certain minerals on the planes of fracture. Phillips,* De la Beche,† Du Noyer, and others are in favour of the former idea.

Mr. Du Noyer says—"The formation of Slickenside on any rock surface is due to the sliding of one rock mass upon the other."‡

* "Manual of Geology." † "Geological Observer." ‡ "Geologist," 1860.

De Saussure, Close, &c., uphold the crystallization theory. Mr. Close contributed an excellent paper on the subject to this Society in May, 1863. Giving an account of his investigations of the phenomenon in the granite of the counties of Dublin and Wicklow, he has used a good deal of reasoning to overthrow the movement theory.

That there should be no controversy in the matter would be desirable; it is unavoidable that such should exist, so long as the one term—namely, Slickenside—is applied to phenomena which only resemble each other in their external appearances.

I believe these external polishings and striations of rock surfaces have resulted from more than one cause; it is quite true they can be produced by friction between rock surfaces during mechanical displacement, &c.; and it would probably be equally correct to say that similar superficial aspects are due to the crystallization of certain minerals in the fissures, which minerals may still remain, or may have been washed away, leaving only their casts behind.

Having assumed the phenomena in question divided, and these phenomena resulting from different causes, it is my duty to describe each of the aforesaid separately.

First, with regard to the striated and polished appearance, which has been set down to mechanical action of rocks on each other. Now, surfaces of rocks in the bed of a river might become striated by gravel, which is constantly driven along before the current; glacier ice would produce the same effect; but we might perhaps find the striæ coarser or deeper grooved, also the surfaces polished more or less in proportion to the hardness of the rocks: the polish would be produced by ponderous masses of ice (being itself free from grit) moving slowly over them, sometimes impressing the inequalities, and sometimes causing slight abrasion—a process somewhat like that of burnishing, in which the surface inequalities of metals (gold, silver, iron, copper, &c.), are laid smoothly, by pressing over the part to be polished a hard smooth-surfaced instrument.

It is also possible that some joint surfaces may have polished and striated each other by friction. Such rocks as have a fine close grain take a good polish; subsequent seismic oscillations, produced by earthquake shocks, may have played an active part. As few geologists will deny that earthquakes were numerous previous to the "Historic Period," it is highly probable they were most frequent during elevations of strata above the sea level. In fine, almost every fault and fissure exhibiting evidence of mechanical displacement must have been attended by a shock of greater or less violence.

De la Beche* says—"When surfaces are striated by motion, the direction of the striæ are generally parallel to the direction of the movement."

The principal characteristics of motion Slickensides are, that the polish on the surface is materially the same as the rock which possesses

* "Geological Observer."

it, and that the striæ are parallel to the direction of displacement, and serve to indicate whether such displacement be horizontal, vertical, or oblique.

Let us now consider the Slickenside which may be attributed to crystallization: it commonly occurs on joint surfaces, as a striated coating, sometimes very thin, and sometimes of considerable thickness; the colour is variable.

The Rev. Mr. Close, in describing Slickensides in granite, says, "the striated surfaces generally consist of black, blackish, or grey quartz." He considers the blackness due to schorl permeating the quartz, and speaks of those striations which he has observed as usually very straight and parallel.

Mr. W. J. Henwood, F. R. S.,* says that "Slickensides occur with tin ore at Polbreen, at St. Agnes with vitreous silver ore of Wheal Brothers, amongst hydrous oxide of iron at Rostromel, and generally in lead mines; they cover the faces of lode walls, and where copper pyrites abound, the striæ run in all directions, in a most irregular manner, throughout the entire substance of the lodes, which sometimes show no other traces of joints: at Wheal Robert they intersect each other in every direction, and thus inclose angular, spherical, and most oddly-shaped masses. Whether the faces of these divisional lines be coated with earthy or metallic substances, they are always marked with striæ; but, although these may be abundant on either side of the lode, yet the directions of the striæ seldom or never correspond; neither are they ever parallel for more than a few inches, but are generally divergent. In these lines breaks of continuity are common, and frequently those which for some distance are nearly straight become curved or irregular; again, the faces on which these markings appear are never plane surfaces, but always have protuberances, lumps, pits, and hollows, and, whether they project or are depressed, are alike marked and polished with as much continuity as the rest."

De Saussure,† in speaking of the Roc Poli, attributes the Slickenside coating (which according to him is composed of quartz and some dark mineral) to crystallization.

We should endeavour to account for the presence of those mineral coatings on joint surfaces. They were evidently deposited subsequent to the joints themselves. Now, joints and their cleavage planes are exposed to infiltration of liquids. It is very common to find in joints and between the cleavage planes of rocks a variety of minerals; the interstices are sometimes lined or filled by layers of quartz, carbonate of lime, sulphate of baryta, or oxides of manganese or iron. These have evidently been deposited from water, which is seldom pure, owing to its solvent property while percolating rocks containing soluble matter. Nearly similar results ensue, whether the water be cold or hot—whe-

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* "Cornwall Geological Society's Transactions," vol. v., pp. 181, 182.

† "Voyages dans les Alpes."

ther it issue from below upwards, or from above downwards. The geysers of Iceland have a temperature of 180° Fahr.; they issue from below, and deposit silica. Thermal springs are common on the Continent of Europe, in America, and in other countries; those of Washita* deposit a copious sediment, composed of silica, lime, and iron. The calcareous deposits, or "travertines," are deposited from hot water, as at San Philippo Baths (122° Fahr.), or from cold water, as at the Apennine Springs.†

I have procured some specimens of trap with Slickenside surfaces from a dyke which intersects the Old Red Sandstone, close to the town of Lamlash; the rock is easily cleaved up into blocks, varying in size, having a quadrangular form, due to sets of joints running nearly at right angles to each other. In some cases the prisms are of more rhombic forms, owing to flexures in the dyke, and the boundary walls not being parallel throughout. On almost every polished and striated surface coating I observed a thin layer of carbonate of lime, I also found thicker veins, and nests of same crystallized in larger fissures, the crystals having many forms. Striated structure is most common, and occasionally the striæ cross each other at nearly right angles. Veins in Carboniferous Limestone often present the same structure, which is (*according to Du Noyer*) frequently accompanied with a black carbonaceous-looking glaze. The fact of finding carbonate of lime having a striated structure accompanied with a black Slickenside coating on rocks of a widely different character, suggests the idea that a relation may have existed between this Slickenside and the carbonate of lime, and that both were probably formed contemporaneously. On detaching these Slickenside coatings from the blocks, no striated structure is to be observed on the rocks themselves. The striæ have evidently been produced by the crystalline structure of the minerals which are found in the veins.

Having thus considered the Slickenside which results from mechanical displacement, also that due to crystallization, as distinct phenomena, I believe it would be wise to abandon the vague use of the term "Slickenside:" it is very expressive of the movement polish; but when we come to describe the polished and striated surfaces of the crystalline type, we want a term to express the latter idea without confounding it with the former. The term enamel would be sufficient for the geologist; for the chemist will remain the duty of distinguishing varieties of the enamel, as I believe there are such.

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* James's "Expedition to the Rocky Mountains."

† Dr. Gosse, "Edinburgh Philosophical Journal," vol. ii.

XXIX.—On the Discovery of the Head and Antlers, with some of the Bones, of the Megaceros Hibernicus, near Kilskeer, County of Meath. By George V. Du Noyer, F. R. G. S. I.

[Read April 11, 1866.]

On the 21st of July, 1865, the head, antlers, and the greater portion of a skeleton of a *Megaceros Hibernicus* were discovered in a shallow gravel pit, at the distance of three-quarters of a mile to the westward of the village of Kilskeer, in the county of Meath, and just south of the main road.

In the following month my attention was directed to this "find" by Captain Rodon, of New Grove, near Kells; and on examining the locality, I found that it was originally a small shallow tarn, and is now a marshy depression, from the surface of which a thin layer of bog had been cut from time to time. Shallow pits had been sunk here and there over this space, from which clear sand and gravel were procured, well adapted for building purposes; but in these water was reached at the depth of about eight feet.

On the northern margin of the marsh, where the remains were found, I noted the following section, the vertical thickness of which was about five feet six inches to the surface of the water:—

1. Thin layer of peat, spreading on to the limestone gravel which surrounded the marsh.

	Feet.	Inches.
2. White marl, stratified,	2	6
3. White shelly marl,	2	0
4. Blue marl,	1	0

the whole resting on bluish sand and gravel, used for building purposes, the thickness of which is not determinable.

I was informed by the men who discovered the remains that the head and antlers lay obliquely to the horizon, and extended throughout the whole series of the deposits named, the end of one of the tines absolutely protruding through the superficial layer of peat.

The basal blue sand and gravel is made up entirely of well-rounded fragments of Lower Silurian rocks; and the water of the old tarn has hollowed out its surface here and there, and deposited on it the blue and white marl. I believe it is generally asserted that the remains of the Megaceros have been invariably found in the marl, shelly or otherwise, which underlies the peat bog, but never wholly in the peat itself—thus leading to the supposition that the animal was destroyed prior to the formation of our bogs. I do not believe that the instance I have now brought before the Society alters this view; for it is possible to suppose that the end of the tine which was observed to penetrate through the thin peat layer may have been denuded of the enveloping marl just before the growth of the peat.

The deposit of blue sand and gravel below the marl is somewhat remarkable, older than the marl and the limestone gravel over it, yet newer

than the boulder clay, and perfectly distinct from it, as it is made up of well-rounded fragments.

This may possibly be a local deposit, derived from the Lower Silurian land, which was about one mile and a half distant from it to the north; yet the currents which formed it can have had no effect on the Carboniferous Limestone, though that is here the subsoil rock.

At other localities in the district around Kells I have observed a deposit of sandy and gravelly clay, with inclosed pebbles and blocks of Lower Silurian rock, though the Carboniferous Limestone is the rock beneath.

In the section observed on the Meath Railway, close to and west of the Kells station, this Silurian gravel is observed to rest on a layer of peat, eight inches thick; beneath this is pale grey marl, permeated by numerous rootlets from the peat layer, and containing large rounded Lower Silurian fragments.

As in some of the midland counties in Ireland I have long ago observed layers of gravel in bog, and bog or peat layers in the gravel, I suppose we must imagine that this peculiar Silurian drift is merely a local deposit, and probably of an earlier age than the limestone gravel, the boulder clay being beneath all. I should hesitate to assert that the blue sand and gravel, beneath the marl in which the Megaceros remains were found at Kilskeer, were of the same age as the Silurian drift over the thin peat layer in the Meath Railway cutting; yet it is quite possible that both deposits may synchronize as to time; and therefore the elk may have roamed through forests in Ireland, the relics of which are now presented to us in such sections through peat and gravel as that on the Meath Railway, and those on the banks of the canal near Tullamore.

In examining the head and antlers, and other bones of the skeleton of the elk from Kilskeer, which are now preserved in the National School of that place, I remarked that one of the bones exhibited a small highly polished notch, similar in character to those cuts and abrasions previously described by Mr. Jukes and Dr. Carte as appearing on the bones and the antlers of the Megaceros.

I may conclude these brief Notes by remarking, that in the summer of 1863—which was one of unusual drought—I discovered in the marl on the eastern margin of Lough Killen, three miles to the west of Granard, in the county of Longford, a vast collection of bones and teeth of the horse, the red deer, the *Bos longifrons*, and various other Mammalia, with portions of a human skull and a human jawbone of that peculiarly short and broad type previously discovered in the marl of Lough Gur, in the county of Limerick, in connexion with some bones of the Polar bear.

I failed to procure any remains from this locality capable of being identified as belonging to the *Cervus megaceros*, yet I see no reason why such should not be found there, as I am fully impressed with the belief that man and the Megaceros lived contemporaneously in Ireland.

XXX.—On the Occurrence of Felstone Traps and Ashes on the Curlew Hills, North of Boyle. By J. Beete Jukes, and F. J. Foot.

[Read May 9, 1866.]

While examining the country immediately north of the town of Boyle, Mr. Foot came on some curious masses of rock, forming conspicuous crags on the summits of the Curlew Hills. The weathered part of the upper surfaces of these crags discloses a number of angular fragments imbedded in a compact base of a dull purple colour, the brecciated character being in some masses very distinct. When the rock is broken open, however, it is often difficult to distinguish one part of it from another except by slight varieties of colour, some angular portions being of a greenish hue, or of a light flesh colour, while the general mass is dull purple.

Facets of felspar crystals are to be observed scattered throughout it; so that it might be taken for a felstone of a mottled concretionary structure, if it were not for the well-weathered surfaces on which the angular fragments stand out, and show the real character of the rock to be a brecciated ash.

Below this capping, which may be in some places twenty or thirty feet in thickness, is a compact Felstone, generally of a dull purple colour, with scattered facets of felspar glittering here and there in the mass.

This rock has in some places, a distinct columnar structure. Its thickness is nowhere exactly determinable, but it also may in some places be as much as twenty or thirty feet.

These masses of rock form the hill tops for some miles east of Lough Key, lying in a nearly horizontal position. In one part they appear to be covered by a bed of quartzose conglomerate, and some beds of reddish brown sandstone, part of the Old Red Sandstone, while in another similar rock rises out from beneath them.

They appear, therefore, to be part of the Old Red Sandstone, and to lie near the summit of the anticlinal that rises between the limestone plains south of Boyle and the limestone hills of Kesh Corran, west of Lough Arrow. The flanks of the Curlew Hills are, however, so buried under drift and strewn over with loose blocks, that it is very difficult to determine the details of their structure.

One little section, in a stream that runs down from the summits of the hills towards Ballinafad, showed the Old Red Sandstone dipping to the north at eighty or ninety degrees; and great masses of vertical conglomerate strike N. E. and S. W. in the hills to the westward of Lough Garra, a little to the S. E. of the curious old castle of Moygarra.

The Felstones seem of a different character from those of the Silurian rocks of Leinster, and those in the Old Red Sandstone, south of Lough Guitane, near Killarney, and more nearly resemble those described by Mr. Geikie as occurring in the Carboniferous and Old Red Sandstone series of Scotland.

Besides the contemporaneous Felstones, there are several vertical dykes of grey crystalline greenstone traversing the Old Red Sandstone of this district. One of these is especially conspicuous, running for upwards of a mile by the side of the upper road from Boyle to Keadue, to the N. W. of Lough Key.

XXXI.—On the Discovery of a Stone Hatchet at Kilbride, County of Wicklow. By Joseph Scott Moore, D. L., J. P.

[Read June 13, 1866.]

The townlands of Knockatillane and Cloghlea (near Kilbride, in the county of Wicklow) are in many places thickly studded with boulders of granite. They appear to have been deposited in groups, covering sometimes fifteen or twenty acres each; they are of various sizes, from a few pounds up to many tons in weight; they do not appear to have been much water-rolled; many of them are rounded on the top, and flat in the base; others partially rounded both top and base; but the rough angularities have in general been worn off. There are three neighbouring mountains—Cefin, Cehaun, and Cefignaun—on the top of each of which there is a remarkable mound or cairn of stones, chiefly granite.

That on Cefin appears to have had a cavity in it, with large covering stones over the entrance, and across the roof; but, whatever the depth may originally have been, it is now nearly filled up with stones which have fallen in from the sides and top. Notwithstanding the agreeable legend of the country respecting them that they were the burying places of Finn M'Coul, Fignian his wife, and John or Haun their son, no doubt Mr. Close would tell us the stones were distributed over that part of the country by icebergs; and that a large berg had caught on the top of each of those mountains, and there deposited its burthen. These boulders are so various in their respective compositions, they most likely were collected in different places; and they differ so much from the underlying granite rocks, that they could not have been torn from them. In splitting the boulders on Knockatillane for the purposes of reclamation, many of them presented inside a spheroidal structure; this was not confined to the smaller stones, but appeared in some of several tons' weight. The specimen now before us is not the best that could have been found to illustrate that structure; but it is produced for the purpose of showing the angular arch over the top of the circle. One trace resembles a Gothic, the other a Saxon arch.

The granite boulders on Knockatillane extend down the slope of the hill, until they are cut off and overlaid by a level deposit of another kind in the valley. This deposit (as appearing at the edge of the river, by which it has been eroded to the depth of about thirty feet) presents at the lowest point a layer of marl, over that several feet of sand and gravel, above that a vein of limestone pebbles varying from

four to seven feet, and on the surface a few feet of alluvial clay. The limestone pebble deposit extends down the valley towards Poolaphuca on the one side, and on the other past the Brittas Millponds, and on to Dublin; but from Knockatillane, ascending to the source of the Liffey, and thence across the range of the Wicklow Mountains until you come near the sea coast, not a particle of the limestone gravel is to be found.

From the circumstance of the granite boulders disappearing on descending the hill, when you arrive at the plain formed by the drift, we may infer that the deposit of the boulders was anterior to that of the drift containing the limestone pebbles.

This is a question deserving further investigation, and more particularly with respect to the circumstance which I am about to bring to your notice. A field in Knockatillane was five years since in a wild state, covered by bog and rock, the bog in some places being four feet deep. By tillage, drainage for four years, and the removal of hundreds of tons of stones, the whole surface of the field has subsided more than a foot, and in many places (where the bog was deep) more than two feet.

On Saturday last, in clearing away stones before the plough, a group of five larger and two loads of smaller stones were met with, lying several inches under the boggy surface. To remove these the pick, crowbar, and spade were necessary; and on turning up the last stone (which was sunk in the hard clay six inches), there was found under it the stone hatchet which I now produce. The stone which lay upon the hatchet was fourteen inches broad, eighteen inches deep, and about two feet long, perfectly flat on the under side, and may have weighed about 3 cwt.; it was firmly imbedded in the earth, tightly wedged in with five other large stones, varying respectively from about one to 3 cwt. The smaller stones found with them were also firmly and closely packed, all as they had been originally deposited; no opening, no hollow by which the hatchet could have fallen in or have penetrated to its position under the stone. The stiff hard clay rose round the base of that and the other large stones to the height of six inches, and from that up to the surface of the ground lay about eighteen inches of bog.

That the hatchet was the work of man's hands there can be no question: observe the beautiful shape, the sharp edge, the polish on the surface of the stone, the notch broken out of the end of the stone to allow the finger to catch on it; and even after that piece was knocked out, observe the surface of the stone around the fracture partly polished again. The question arises, How did the hatchet get under the stone? was it washed in by flood at a time before the bog had grown, and before the six inches of clay had arisen about the base of the stone? had it been hidden there by a native, who had scraped a hole under the stone for the purpose of concealment, and was that hole afterwards in the lapse of time filled up with clay, and the whole covered over with a growth of bog to the depth of three feet? or, finally, was it lying on the

surface of the earth before the glacial period—before the granite boulders were deposited, and had sunk by their weight in the hard clay surface—before the country to the highest hill tops was covered with water and floating ice, and before the drift had filled the valley with rounded and water-rolled limestone pebbles, brought from afar, washed up from the lower countries—before the sands and gravels (the *detritus* of the mountains) had been hurried down by the torrent, and ground to powder by rolling, rubbing, and grating together?

But whither would this contemplation lead us back? to what incalculable period of time must we through this vista search for the first appearance of man upon the earth! We know not. Wondrous are Thy works, O Lord, past finding out; Thy ways have been of old, from everlasting; and Thy mercy endureth for ever.

XXXII.—On the Chemical Composition of some Zeolites, presented by Colonel Montgomery to the Geological Museum of Trinity College, Dublin. By the Rev. Samuel Haughton, M. D., F. R. S.

[Read June 13, 1866.]

Some months ago Col. Montgomery presented to the Geological Museum of Trinity College some fine specimens of Zeolites, found by him in the Bombay Presidency, four of which seemed to me worthy of chemical analysis, and of being recorded in the "Journal" of this Society:—

No. 1.—*Apophyllite.*

This mineral occurs in fine clear crystals, coating the foliated stilbite, No. 2. These crystals occur in the Dimetric system. The chemical analysis gave the following results:—

No. 1.—*Apophyllite.*

		Oxygen.	
Silica,	51·60	26.791	26·902
Alumina,	0·24	0·111	
Lime,	25·08	7·130	8·175
Magnesia,	0·08	0·031	
Soda,	0·63	0·160	
Potash,	5·04	0·854	
Water,	16·20	14·399	
Fluorine,	0·97	..	
	99·84	49·476	

This analysis agrees very well with those of apophyllite given in the books, but it is very difficult to assign its rational formula; it has been proposed to borrow as much oxygen from the water, as added to that of the protoxides, would give the formula,

$$3\,RO,\ 2\,SiO_3 + 2\,HO;$$

and such a substitution is mathematically possible in this example ; but I have no faith in such imaginary combinations.

The stilbite (No. 2) occurred in flat radiated crystals, readily distinguishable by the eye as those of stilbite.

Its analysis gave :—

No. 2.—*Stilbite.*

		Oxygen.	
Silica,	58·20	30·217	
Alumina,	15·60	7·291	
Lime,	8·07	2·294	2·574
Soda,	0·49	0·125	
Potash,	0·92	0·155	
Water,	18·00	16·000	
	101·28	56·082	

This analysis gives very well the usual formula of stilbite, regarded as a hydrated lime orthoclase :—

$$\mathrm{RO,\ SiO_3 + Al_2O_3,\ 3\ SiO_3 + 6\ HO.}$$

The foregoing analysis may be compared with that of very finely crystallized stilbite found by Mr. Jacob in the Nerbudda Valley, which was published by me in Note V. on Mineralogy, in the "Phil. Mag." for July, 1857.

The next mineral to be described is especially interesting, because it seems to set at rest the controversy as to the specific identity of hypostilbite, and fully establishes the title of that mineral to be regarded as a distinct species, and not a degradation of stilbite produced by hydrous metamorphism. It occurs in large fibrous transparent masses, radiated like natrolite or Thomsonite, and filling globular cavities in green trap.

No. 3.—*Hypostilbite.* Sp. gr. = 2·180.

		Oxygen.	
Silica,	52·80	27·414	
Alumina,	17·12	8·001	
Lime,	7·89	2·242	2·854
Magnesia,	trace	..	
Soda,	2·35	0·601	
Potash,	0·07	0·011	
Water,	18·52	16·462	
	98·75	54·731	

This analysis is very like that published by me of a specimen of hypostilbite from Skye ("Phil. Mag.," July, 1857), and it also resembles the original analysis of Beudant. It may be regarded as an hydrated lime oligoclase, with the formula,

$$\mathrm{RO,\ SiO_3 + Al_2O_3\ 2\ SiO_3 + 6\ HO.}$$

The fourth specimen of Zeolite to be described occurs in large massive nodules, filling cavities in trap, of feathery structure, and apparently metamorphic in origin:—

No. 4.—*Harringtonite.* Sp. gr. = 2·174.

		Oxygen.	
Silica,	45·60	23·676	
Alumina,	27·30	12·760	
Magnesia,	trace	...	4·257
Lime,	12·12	3·444	
Soda,	2·76	0·707	
Potash,	0·63	0·106	
Water,	12·99	11·545	
	101·40	52·238	

This mineral is identical with the Harringtonite of the books, but it seems difficult to assign its true formula.

XXXIII.—On the Analysis of some Lavas from New Zealand. By the Rev. Samuel Haughton, M. D., F. R. S.

[Read June 13, 1866.]

I am indebted to Dr. Lauder Lindsay for the opportunity of making the following analysis of volcanic rocks from Dunedin, in New Zealand.

I. Basalt, with visible crystals of augite and chrysolite; Dunedin, New Zealand:—

	Per cent.
Silica,	46·60
Alumina,	16·80
Peroxide of Iron,	7·28
Protoxide of Iron,	5·76
Protoxide of Manganese,	0·72
Lime,	9·65
Magnesia,	6·89
Soda,	6·78
Potash,	2·08
Titanic Acid,	trace
	102·56

II. Vesicular augitic Lava, with cavities destitute of lining crystals; Mount Eden, Auckland, New Zealand. This Lava is divisible into two portions—respectively soluble and insoluble in muriatic acid:—

Soluble,	38·2
Insoluble,	61·8
	100·0

It contains only a small quantity of carbonates, and seems to have undergone but little metamorphic action:—

	Insoluble. grs.	Soluble. grs.
Silica,	33·20	13·50
Titanic Acid,	1·10	0·31
Alumina,	8·80	2·90
Peroxide of Iron,	2·14	0·60
Protoxide of Iron,	2·70	5·70
Protoxide of Manganese,	0·16	0·10
Lime,	5·40	2·52
Magnesia,	2·76	8·55
Soda,	3·74	2·23
Potash,	0·54	0·23
	60·54	36·64
Loss,	1·26	1·56
Total,	61·80	38·20

III. Vesicular augitic Lava, with cavities lined with white crust; Dunedin, New Zealand.

This Lava, like the last, is divisible into two portions—soluble and insoluble in muriatic acid:—

	Per cent.
Soluble,	40·40
Insoluble,	59·60
	100·00

It contains large quantities of carbonates, due to metamorphic action:—

	Insoluble. grs.	Soluble. grs.
Silica,	33·00	9·24
Titanic Acid,	0·80	0·30
Alumina,	9·00	4·44
Peroxide of Iron,	2·09	4·07
Protoxide of Iron,	1·15	4·43
Protoxide of Manganese,	0·16	0·10
Lime,	8·08	2·13
Magnesia,	3·04	6·09
Soda,	1·76	0·83
Potash,	0·88	0·21
	59·96	31·84
Gain,	0·36	
	59·60	
Carbonic Acid, Water, and Loss,		8·56
		40·40

The portion of a Lava which is soluble in muriatic acid consists of carbonates, magnetic oxide, and an unknown silicate of alumina and soda; it therefore varies considerably, according to the degree of metamorphism the Lava has undergone subsequent to its emission. On re-

ducing the insoluble parts of the preceding Lavas to percentages, we find:—

	Insoluble portion of Dunedin Lava. No. I.	No. II.
Silica,	53·72	55·37
Titanic Acid,	1·78	1·34
Alumina,	14·24	15·10
Peroxide of Iron,	8·46	3·51
Protoxide of Iron,	4·37	1·93
Protoxide of Manganese,	0·26	0·27
Lime,	8·74	13·56
Magnesia,	4·46	5·10
Soda,	6·05	2·95
Potash,	0·87	1·47
Loss,	2·05	
		100·60
	100·00	Gain, 0·60
		100·00

This seems to be a mixture of labradorite and augite, and is very constant in the two specimens examined.

XXXIV.—Notes on some Physical Features of the Land formed by Denudation. By A. B. Wynne, F.G.S., &c., &c.

[Read November 14, 1866.]

The subject of these Notes is of great magnitude, so that no detailed treatment of it can be attempted in a brief communication like the following.

It must have occurred to most observers that there is a very general resemblance between the physical features of all countries, notwithstanding local exceptions to the rule; for mountains, glens, valleys, plains, and islands are features of nearly every land. This similarity of forms would seem to suggest some conditions capable of universal application, in order to account for their production.

The actions of the sea and atmosphere, assisted by subterranean agencies, are of this nature, and are generally held to have been sufficient to cause all the varieties in the forms of the land; but the amount of the effect produced by one or other of these agencies has been variously estimated in tracing the features to their origin.

What the atmosphere has done towards producing these forms may be to some extent appreciated by observing the differences between the features of countries which have been subjected to different extremes of temperature. Yet the disparity between the features of some countries which have been glaciated and those of some tropical ones, though evident, is not so striking as might have been anticipated from great difference of climate; for instance, some mountains in Nubia and some in Sligo are not greatly different in shape, though one case is in glaciated Ireland, and the other in the so-called rainless region of the Red Sea.

Nor are the results of these two extremes of atmospheric action nearly so marked with regard to the features of a country as those which arise from the structure and position of different rocks.

It is hardly necessary to call attention to the enormous amount of denudation which has been in operation from the most remote periods, producing irregularities in the land, and at the same time forming a thickness of sedimentary deposits which is estimated in these countries at about seventeen miles;* or to the important assistance rendered by elevation and depression, in placing the rocks within reach of denuding agencies which do not act in the depths of the ocean.

As it is safer to speak concerning the forms of the land than of those beyond general observation beneath the sea, these Notes will be chiefly confined to the former; and as volcanic cones have so slight connexion with features of denudation, we shall pass them over.

Although the forms of the land in our own country bear witness to the great influence exerted by atmospheric agencies in wearing away the rocks, the extent of this kind of denudation will be more readily admitted by those who have studied its effects in such a country as Tropical India, within the region acted upon by the south-west monsoon, where valleys of profound depth have been thus eroded, and many of the hills have peculiarly fantastic forms produced thereby, but still closely related to the varieties of their component rocks.†

The granitic and trappean rocks of Western India have both yielded to a powerful denuding agency; but, although numerous examples could be placed before the meeting, and indeed might be multiplied indefinitely, the shapes varying with every structural condition of the rock masses, yet the eye soon becomes able to distinguish and appreciate the many characteristic features produced by the wasting agencies of heat, and rain, and wind.

In India, again, one of the most palpable evidences of atmospheric denudation consists in the vast quantities of alluvium which have been

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* Professor W. King's "Geology at a Glance:" A. Thom, Dublin.

† A few instances were given in the diagrams exhibited to the meeting. Some of these were outlines of granite hills, showing a large amount of atmospheric weathering, the most peculiar being one called by the natives "Dantwarra," from the resemblance a portion of the hill bears to a tooth. Another elevation in the same country, and about 800 feet high, presented a fine example of the spheroidal and dome-shaped forms which granite sometimes assumes under atmospheric disintegration; the whole mountain exhibiting huge concentric shells of naked rock, large portions of which had been removed by atmospheric weathering from between the joints, while here and there spherical masses, not yet quite separated, remained perched on its summits or sides—their grouping much resembling the figures given in Colonel Meadows Taylor's paper on the Geology of Shorapoor, in the Deccan ("Journal of the Geol. Society of Dub.," vol. x., p. 24).

The outlines of the trappean hills which cluster about the approaches to the mural range of the Western Ghâts, were referred to, as showing in many instances the great extent to which atmospheric erosion has acted, producing pinnacles and castle-like forms, as well as deep clefts, and tall slender detached pillars of rock. It is hoped that some of these varieties of granitic and other hill forms may be noticed in forthcoming memoirs of the Indian Survey relating to the countries which have been lately surveyed on the western side of the peninsula. We cannot do more than make a passing general allusion to their existence, in connexion with the subject of this paper.

produced by it, and brought down to lower levels by the heavy floods common to the country. Some of these accumulations cover great areas to unknown depths (in many places, where they are thin, exceeding 200 feet), and for hundreds of square miles they completely conceal the underlying rocks, producing recent formations of an extent as great as that occupied by some of the older ones known to European geology.

The well-known facility with which limestones yield to excavation and reduction by rain water illustrates an extreme case of this action, which no rocks are known completely to resist.

One interesting example is shown by the action of the waves of Lough Corrib, in Galway, upon some horizontally-bedded grey compact Carboniferous Limestone near Oughterard, the peculiarity of which is to wear into nearly circular cavities, averaging about four inches in width and depth, both irregularly grouped, and along the lines of jointing; at another place numerous deep runnels occur all over the upper surface of a very similar limestone bed, exposed upon a rocky hill, within four or five miles southward of the same locality, the joints of the hard stone being eaten away to a width and depth fully equalling in size the largest cracks produced by the sun in the black soil of the plains of India; and the rain-worn fissures frequently penetrating beyond twelve or fifteen feet in a vertical direction.

Caverns in this rock are too common features to require more than a passing notice; but such occurrences as boulders of different rocks resting upon pedestals of limestone, called sometimes by the country people, "mushroom rocks," bear testimony both to the transporting power of ice, and to the way in which the neighbouring limestone has been attacked and dissolved from around and beneath them. A good example of this occurs at Gurtagass, in the valley of Kenmare (see cut), and another on the limestone hills at Lacca, in Sligo.

The extent to which the wasting action takes place upon limestone

leads Professor Jukes to suggest that this rock has been thus removed from large valleys in the South of Ireland, if not also for a very considerable depth from above the whole of the central plain of the island.

In the Burren Hills, in Clare, and in the county of Sligo, large and deep valleys in the limestone exist, along the sides of which are evident traces of the wasting of the rock by the atmosphere; and from the Sligo glens great masses of drift project, which have plainly been derived from the adjacent mountains; their present situation being, however, very probably due to the agency of ice during the glacial period.

The author of "Rain and Rivers" supposes all rocks to have been so much acted upon by atmospheric agencies, that the principal features of the land have been carved out by them alone; and several writers upon the subject coincide more or less in his views.

Looking only at these instances from limestone countries, there would be little difficulty in believing the subaërial agencies equal to the results, or in attributing to their continuous action the excavation of the deepest valleys; but these have not all been excavated out of limestone; some glens in the vicinity of the Sligo examples, for instance, having been cut across a chain of mountains composed of micaceous, gneissose, and other hard Metamorphic rocks. In the country from which our first illustrations were taken conspicuous features of the land are high mountain cliffs, and wide undulating plains. One range of cliffs—that of the Western Ghâts, with minimum heights, near Bombay, of 2000 feet above the sea—extends for a distance of about 600 miles along the western coast of Hindostan, having between it and the sea a belt of country often 30 or 40 miles wide, which is low, and in many places nearly flat. The range forms for a considerable portion of its length an escarpment to the horizontally bedded traps of the Deccan, which there is every reason to suppose were once continuous to the west, and out to seaward, burying the present low country beneath a depth of two or three thousand feet of rocks, which have all been removed by denudation of one kind or another.

In support of the idea that this denudation was marine, it may be mentioned that sea shells are said to have been found within caves situated at a great height in the faces of the cliffs of the Ghâts near Vingorla, or Sawuntwarrie, in the southern part of the Bombay Presidency. It must, however, be borne in mind, that this chain of cliffs faces the full force of the south-west monsoon, and during that period rain almost continuously falls upon it, sometimes to the extent of twelve inches in as many hours; one result of its excessive action being very visible in the numerous steep ravines with which the range abounds. (See "Memoirs of the Geological Survey of India," on the Geology of the Island of Bombay. By the author.)

The plains were most probably produced, as others have been elsewhere, by marine agencies of former periods; and how they can be attributed to atmospheric action alone, it is difficult to understand; for this appears to produce most frequently steep slopes or abrupt ground, except in the case of alluvial flats, on which *the results of subaëreal denudation* are accumulated.

The ground beneath such flats, however, judging from what river sections teach, must have a surface often undulating at but low angles, and without prominent features. If the action of the atmosphere be insufficient to produce this state of things, the agency of the sea must be looked to in order to explain their occurrence.

We know that the surface only of the sea acts powerfully upon the land; and that, if this action were indefinitely continued upon a tract of homogeneous rocks while the land was at rest, a plain would be formed. As the land, however, is not homogeneous, even if it had remained at rest for very extended periods, we should anticipate irregularities in the forms resulting from marine erosion; and if it were slowly moving up or down, these would be combined with various sloping outlines, which would correspond with the rate at which the land had been elevated or depressed, and thus might be produced the many undulations of lower and more open portions of the ground.

When there were such conditions as the land remaining stationary for long periods, marine cliffs would be formed; and were the rocks of a material and in a position favourable to the taking of this shape, we may suppose that such strong features would not readily become obliterated by subsequent atmospheric action. In this way perhaps may have been produced the long lines of cliffs on the sides of the Benbulben Mountains, in Sligo, or those on the Burren Hills, in Clare. Looking southward from the north side of Galway Bay, the terraces of the latter may be plainly seen at a height of about 600 feet above the sea, stretching like a belt along the whole range of the hills from Black Head eastward. A nearer view of some of these terraces would present forms similar to those seen in Glen Columbkill (Burren), where the nearly horizontal scarps of the limestone beds project from, and curve round the sides of hills which stand upon rugged sheets of rock, partially concealed here and there by mounds of drift strewn over with detached blocks. One feature of these Burren Glens deserves notice. Viewed from Galway, the terraces can be traced by the eye entering each valley, and reappearing at the same level on its other side. This character is not common along the bays of our present coasts; something of the kind has been observed in straits, but where a bold shore line bends into a deep bay, the cliffs generally sink and disappear within it (as has been noticed by Mr. Mawe, in a recent number of the "Geological Magazine").

If the Sligo and Burren limestone cliffs* owe their origin to marine denudation, they are evidence of the land having rested at several different levels; but, as we cannot tell how unequally it may have moved, it is perhaps possible that some of the features in each of these distinct localities were formed at the same time, although their levels are widely different with regard to that of the sea at present, and the number of the terraces does not agree.

The mountainous country between these two localities is not formed

* See an article on Denudation, by the author, "Geol. Magazine," January, 1867.

of limestone, and, although abounding in cliffs, and full of splendid examples of glacial smoothing, does not present terraces like these; while the passer-by along the tourist's route may often look in vain up and down the steep straight outlines of the mountains for a feature to mark a place against which the sea beat for any lengthened period; so that we must conclude, either that continuous seamarks were never made here, or that they have been obliterated by atmospheric action. Some features, indeed, strike one to occur at nearly the same height, such as the coombs in the neighbourhood of the Killeries, which, if they were now at sea level, would form little bays like that at Coois, under Mount Brandon, on the Dingle promontory; but whether these were excavated by the sea, or by ice, we do not undertake to say.

The bold sea cliffs outside this long inlet of the Killeries are replaced within it by smooth slopes; and all that the sea at present seems to effect there is to cut a small bank out of the "rain wash" which has dressed the mountain sides.

Conclusion.—From these observations, and the examples cited, it will be seen that the shapes of the land are similar to some extent upon the large scale; and further consideration would show the most striking features are more often due to the *amount*, than to the *kind* of denudation engaged in producing them. That there is sometimes considerable difficulty in distinguishing to which kind of denudation, whether atmospherical or marine, some of the forms are due, will also be admitted; but that most of them have been within reach of, and acted upon by, both agencies cannot be denied; still we must remember that, while the atmospheric agencies can exert their power to reduce the features which they themselves appear to form, they can also labour to obliterate those which may have been derived from the former action of the sea—a cause which may therefore be lost sight of, although perhaps having been active in determining many of the original shapes of the physical features of the land. Ages must have passed away since many of these features could have been directly beneath the influence of the sea; and they must have been exposed ever since to the wasting agencies of the air: we do not find that they have been worn away, nor may we conclude that their outlines have become less varied or less striking; and we are therefore led to the conclusion that, whatever may have been the shapes impressed upon the land by ancient marine erosion, the features of the present are *chiefly* due to atmospheric wasting and washing away, this action developing different forms out of different materials, or out of similar materials under different conditions.

XXXV.—Notes of a Visit to the Granitic District of Strontian, Argyllshire. By Robert H. Scott, M. A.

[Read January 9, 1867.]

I have in former papers expressed my conviction that the correspondence which exists between the geological charcter of parts of Norway and the county of Donegal would be observable also in the south-west of Scotland. In the course of last summer I visited Argyllshire, in order to obtain evidence on this point, and also to seek for more information on the question of the origin of granite and its relations to other rocks.

When the Committee were preparing their Report on the Granites of Donegal, presented to the British Association in 1863, we obtained, through the kindness of Sir R. I. Murchison, several specimens of granites from Scotland, two of which, labelled, respectively, "Tobermory, Mull," and "Strontian," were analyzed by Professor Haughton. The results of the examination of the former were the following:—

Silica,	70·60	*Carried forward,*	91·35
Alumina,	16·40	Magnesia,	1·00
Iron peroxide,	1·52	Soda,	4·14
Iron protoxide,	0·36	Potash,	4·29
Lime,	2·47	Manganese protoxide,	·48
Brought forward,	91·35	Total,	101·26

On more accurate inquiry into the locality, Professor Haughton found that no granite occurred *in situ* at Tobermory, and was informed that the specimen came from Strontian, where it had been quarried. I have most carefully investigated the question, and find that there is no quarry at or near Strontian itself from which such a specimen could be procured. The granite of which it is composed is of a coarser grain, contains less mica and more feldspar, particularly orthoclase, than that found near Strontian. From the very close resemblance of the specimen in question to the boulders with which the district of Upper Lorn is covered, and of which I brought several fragments from the neighbourhood of Taynuilt, I am disposed to think that it too has a similar origin; and the more so, as I am informed that granite boulders are common in the part of the island of Mull lying near Tobermory. This boulder granite is a very remarkable rock. I have found boulders very like it at the King's House in Glencoe; and as that lies at the northern edge of the patch of granite composing Ben Cruachan, and of which the southern limit is at the Pass of Awe, near Taynuilt, it would be a very interesting point to find whether the rock is *in situ* anywhere in the district. A friend of mine had promised to investigate this question for me, but I regret to say that a serious accident prevented his attempting to make a geological excursion.

From Taynuilt I visited Bunawe Quarry, on the north shore of Loch Etive. This is worked by Mr. Symes, for paving-stones for Glasgow. The rock is a fine-grained elvan, of which the feldspar is mainly anorthic;

it sometimes contains sphene; but its most important characteristic is the abundance in it of included fragments of slaty rocks, many of which are angular, and are but little altered from their original texture. This rock appears to me to be decidedly of an igneous origin. It is traversed by dikes of a red quartziferous felstone. I am informed that there is another quarry of a similar nature six miles further up the loch, but the stone is said to be of a coarser character. The mountain itself in which the quarry occurs appears to be of a grey granite, consisting of anorthic feldspar, quartz, and black mica, and very closely resembling the white granite of Strontian, to which allusion will be made hereafter. The only point to which I would now draw attention is, that it occurs here on the north-west shore of Loch Etive, and therefore on the western edge of the granite of the district.

On Loch Leven there are two quarries—one at Ardshiel, and the other close to the steamboat pier of Ballachulish. The stone of each is elvan, answering in every particular to the description already given of the stone worked at the Bunawe Quarries. Red veins, however, are more abundant here than at Bunawe. Granite of a similar character extends along the shore of the loch to a point near the Established Kirk, two and a half miles from the pier. There it is succeeded by gneiss, which at Duach Point changes into mica slate; and this gradually loses its micaceous character, exhibits in parts traces of serpentine, and finally passes into the roofing slate of the Ballachulish Quarries.

It appears to me to be a question of considerable interest to ascertain whether there is any connexion between these two patches of granite so similar in their character.

At the opposite side of Loch Linnhe, in Ardgour, the rock from Corran down to Inversanda is a reddish fine-grained gneiss, with red veins of feldspar, similar to those about Lough Errig, on the south side of the Guibarra Valley, in the county of Donegal. The gneiss at times assumes a granitoid character, and I am informed that there is a granite quarry at Kingairloch; I believe that it is in this granitoid gneiss. This rock extends up Glen Tarbet, across the col, to a point within four miles of Strontian Village. The most remarkable thing about it is its absolute bareness. I have never seen anywhere such an extent of bare rock with scarcely a trace of vegetation, or any sign of chemical disintegration of the rock.

When we first meet the granite at its junction with the gneiss, it is very full of veins of feldspar, another point of resemblance to the granites of Donegal. It extends for a distance of about eight miles in an east and west direction, coincident with the axis of the upper portion of Loch Sunart, along whose shores admirable sections are exhibited. Its extension in a N.E. and S.W. direction I was not able to ascertain. In the small geological maps of Scotland, the only sources of information open to me, the patch of granite is put down as of an oval shape, its major axis running N.E. and S.W.; but I have not been able to ascertain on what authorities the boundaries of the granite have been set down.

In its texture the granite is very coarse-grained, and of a very dark colour. It contains red orthoclase, with another feldspar, which is white, transparent, and highly striated, and quartz; and in addition a large proportion of black mica and hornblende, with crystals of sphene, and possibly of zircon. The most remarkable thing about it is the abundance of nests of black mica, containing crystals of the white striated feldspar and quartz. In these nests the crystals of sphene are far more abundant than they are in the granite itself. The appearance of these nests of mica is most characteristic of the whole district; and they seem to lie in the granite in lenticular masses, and, as I am disposed to think, in beds, like the masses of Lydian Stone in the limestone about Dublin. They were not abundant enough for me to determine the strike by them, but they certainly gave me the idea that traces of the original stratification of the rock were to be found in them.

I attempted to obtain a sufficient quantity of the striated feldspar for analysis, in order to determine finally which of the anorthic feldspars it was; but, notwithstanding the amount of care spent on picking out pure fragments, the analysis showed that the specimen analyzed was not free from quartz. The blowpipe reaction was like that of oligoclase, but the mineral was soluble to a certain extent in hydrochloric acid; so that I am disposed to think it is a more basic feldspar, possibly labradorite or anorthite, but containing principally soda, not lime.

In some places these lenticular masses are developed to a greater extent than in others. At the Free Kirk on the shore at Ardnastaing, the whole rock is changed in texture, and converted to a coarse-grained porphyry, containing pink orthoclase in crystals $1\frac{1}{2} \times 1$ inch, large crystals of anorthic feldspar, and a small quantity of mica. The crystals of orthoclase are much weathered on the surface, and the rock has externally an appearance resembling the *rapakivi* of Finland, as there is a core of orthoclase surrounded by an envelope of another feldspar: this appearance cannot be traced on fracture. The porphyritic granite I have noticed again in other places, especially at Alt-na-Guillam, behind the Manse on the road to Scotstown.

Beyond Ronachan the granite becomes greenish, passing into a rock resembling the fine-grained syenites of Donegal, especially that of Lough Anure, which are there decidedly interstratified with the gneiss and granite. This rock is succeeded by grey anorthosite granite, with red veins. This is the second granite from Scotland analyzed by Professor Haughton, with the following results:—

Silica,	62·09	*Carried forward,*	85·61
Alumina,	17·60	Lime,	4·95
Iron peroxide,	4·78	Magnesia,	3·17
Iron protoxide,	0·74	Soda,	4·08
Manganese protoxide,	0·40	Potash,	3·25
Brought forward,	85·61	Total,	101·06

This anorthosite granite occurs also at the mine of Bell's Grove, and also at the bridge a mile below the mine of Fe Donald. It resembles

very closely that which I have before described as occurring near Bunawe Quarry. At Strontian it certainly appears to form the outside band of the granite on its western edge, or, as I am disposed to consider it, its lowest bed.

The granite, as a whole, appears to me to be decidedly stratified, with a strike of about N. 35° E., and a dip of about 30° E. Other evidence of stratification is afforded by the presence in it of large masses of gneiss, as at Ardnastaing, on the face of the hill by the shore, and also in the glen behind it, on the road from Ronachan to Scotstown. These points are more than a mile from the external edge of the granite area. The phenomena are precisely similar to those which I have so often described in my papers on Donegal.

The junction of the granite and gneiss is most beautifully shown at Stron na Servie, on the north shore of the loch, and also on the opposite cliff. On either side of the loch it is exhibited on a smooth rock face; and there is not the slightest sign of any intrusion, disturbance of strata, or solution of continuity of any sort or kind. It is to my mind very difficult to reconcile such an appearance with that of a true igneous and eruptive origin for the granite.

The district is everywhere penetrated by igneous dykes of most varied texture; some are of trachyte and felstone, others of amygdaloid, or of basalt, and some even of the coarse trap which occurs at Maiden Island, near Oban, and which when weathered looks like an aggregate of crystals of augite.

The gneiss of the western district is very micaceous, and is bedded nearly vertically. It is very different from that already described as occurring at Sallachan and up Glen Tarbet, which is granitoid. Here, however, it more resembles mica slate, and is full of quartz veins and elvans. The chief minerals noticeable in it are quartz, orthoclase, black and white mica, and garnets, for which the top of Ben Resipol is a well-known locality. I have found a single block containing schorl, but have not noticed the mineral *in situ;* however, travelled blocks are not common in the district.

Having examined the north shore, I crossed the loch, and was not a little astonished to find that the two sides differed most materially in composition.

The granite on the southern shore is on the whole more micaceous and hornblendic; but the chief difference consists in the presence of large masses of hornblende rock. This occurs at Liddisdale, where it extends for some distance along the shore. At Achaleach a large development of fine-grained syenite occurs, resembling the greenish syenitic granite of Ronachan, opposite, but at times becoming very coarse-grained. As to the mode of occurrence of this syenite and hornblende rock, I could not satisfy myself. Their appearance and texture are precisely analogous to those of similar rocks in the North-west of Ireland; but at Liddisdale and Achaleach they do not seem to be bedded with the granite, as is the case in Donegal. This point requires further investigation.

In addition to making the section afforded by the two shores of the

loch, I examined the granite on its western edge at two localities inland—viz., at Bell's Grove, and the other mines on the same lode which are near it, and at the mine of Fe Donald, at the head of Glen Strontian. In each case I met with a succession similar to that observed on the shore—the anorthosite granite lying at the extreme edge, and succeeded at Fe Donald by two peculiar types of gneiss. One of these is absolutely identical with the granite as to mineralogical composition, while the other is very different, and is chiefly remarkable for what may almost be called its porphyritic character. This consists in the occurrence of large crystals of feldspar disseminated through a rock which is otherwise fine-grained in texture. Both these varieties of gneiss afford a strong contrast to the types of rock with which we meet in Glen Tarbet and Ardgour, on the one side, and at Ben Resipol, on the other.

The mines of Strontian,* for which it has so long been famous, are lead mines; they were first let to the Duke of Norfolk and Co.; and then, in 1722, Sir Alexander Murray, of Stanhope, the proprietor, let them to the York Building Company. This gentleman did a great deal to develope the resources of his estate: in addition to the mines of Strontian, he worked lead mines at Lurg, in Morven, beyond Liddisdale; in his time a map of the district was published by Bruce, in 1733; I have not yet had an opportunity of seeing this map.

The mines at Strontian were announced by Sir A. Murray as the most wonderful discovery of the age. They were worked extensively in his time by English miners, who built a village called New York at the mines: the ruins of the works are still standing.

The mines in Glen Strontian are worked now† only at Fe Donald: the workings at the other mines having been allowed to fall in, so that any attempt to reopen them would probably be attended with danger. The lodes are exactly on the junction of the granite and gneiss; and it appears to me to be rather a vague statement to say that the minerals, for which the locality is famous, occur in veins in the granite. The fact appears to be, that they are found in no veins, except the one or two which are worked as mineral lodes. These barytic zeolites, Harmotome, with its variety, Morvenite, and Brewsterite, are now comparatively rare, while Strontianite is hardly to be met with. The great locality for these minerals, Whitesmith, is quite closed up, but still I was fortunate enough to find a few good specimens among the heaps of rubbish. Sir Thomas M. Riddell, the present proprietor—who was so kind as to afford me every facility for exploring the district—showed me a collection of specimens, dating from the old days of the mine, many of which are of great beauty. I received several valuable specimens from him, which are preserved in the Museum of the Royal Dublin Society.

As regards the lodes themselves, the absence of fluor spar and the great rarity of heavy spar are remarkable facts, as these minerals are

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* See the "New Statistical Account of Scotland," Parish of Ardnamurchan. Edinburgh: Blackwood, 1843.

† August, 1866.

so commonly associated with lead. At Fe Donald there is a tradition of an antimony lode not now worked, and there is a record of a *steel ore* very rich in silver. The lead at present contains very little silver.

Mines have been opened to the west of Glen Strontian, at Carn Tuohy, under Ben Resipol. Here the lode is in the gneiss; and it is accompanied by trap dikes, as is the case in the other mines; the barytic zeolites are found here also. From Mr. Bright, the present manager of the works, I obtained much interesting information as to the district.

It appears to me, then, after a cursory examination, that as a whole the granitic district of Strontian affords confirmatory evidence of the truth of the theory advanced by the British Association Committee, that the granite of Donegal is not purely igneous, but metamorphic in its origin. At Strontian we do not find all the varieties of rock which occur in Donegal. A most remarkable exception is limestone, of which I could find no traces in the estate of Sunart, excepting at the mines. However, I find in a series of Scotch rocks, in the Royal Dublin Society's Museum specimens of limestone, labelled "Ardgour," and associated in the collection with other rocks very similar to those noticed by me. This limestone resembles very closely the blue crystalline marble so common in the metamorphic rocks of the North-west of Ireland. Another characteristic rock of the last-named district, which we have called sphene rock, is entirely absent from Sunart.

I hope, if circumstances allow me, at some future time to visit Strontian, and by an examination of the adjoining portions of Morven and Ardgour to clear up the relations of the granite to the adjacent rocks, which are as yet uncertain, at least in many particulars. My endeavour in the present paper has been to place on record facts, as I observed them, with the hope that even this short visit may have contributed something to our knowledge of the granites of these islands.

XXVI.—Report of Council.

[Read at the Anniversary Meeting, on Wednesday, February 13, 1867].

The Council, in presenting the Third Annual Report of the Royal Geological Society, have to congratulate the Fellows on the large increase in the number elected during the past year, and the valuable communications which have been made to the Society. However, they regret that the changes on their list have been more than usually extensive. Eleven names have been removed from our number by death, or by resignation; one has been erased for nonpayment of subscription; while fourteen new Fellows have been elected during the year, making an increase of two on our list. Those whom the hand of death has taken from us have been five in number—a very large proportion for so small a body as ours; several of them have been men whom we could ill

afford to lose, as they were only at the commencement of their career, which gave so fair a promise of future eminence; others have been gathered to their rest after a long life of activity and usefulness. Among the latter we must first mention the venerable Head of the College within whose walls the Society has been admitted. Dr. Richard Mac Donnell joined the Society in 1852; though he never contributed papers to our "Journal," he was for many years one who attended the meetings with regularity, and up to the last year of his life visited the Geological Lectures in the University with great assiduity. It would ill become us to attempt to trace his scientific career, but we cannot but add our tribute of regret at the loss of one whom all around us deplore.

Mr. Thomas Hutton was one of our oldest Fellows, as we find his name in the original list of the Society: though he, too, was not the author of communications, yet he never failed to exhibit the interest which he took in our proceedings.

Within the last few weeks we have lost one of our most active Fellows by an accident, and the blow has been more poignantly felt from the remembrance, that he lost his own life in the effort to save others. Mr. Frederick J. Foot was only thirty-seven years of age, but has been well known for many years to most of us, from his connexion with the Geological Survey; and one short paper of his appears in the present number of the "Journal." His most important botanical communications were made to the Royal Irish Academy, and Natural History Society of Dublin, and have most deservedly attracted attention. His geological observations have appeared from time to time in eleven numbers of the Explanations published by the Geological Survey; and his name appears on thirty of their published maps, and seven of the sections. All who have been brought into contact with him know how freely he communicated his own knowledge to those engaged in kindred pursuits; and we need not look further than to the pages of the current number of our "Journal" to see how frequently his authority is referred to by Mr. Close in his paper on Glaciation.

During the year which has just passed many papers of great interest have been communicated to us. Two of these on kindred subjects—viz., Drift and Glaciation—deserve more than a passing notice. Mr. Kinahan's "Notes on some of the Drift in Ireland," bear evident traces of the great care with which its author has recorded his observations. After enumerating the various phenomena noticed by him, and discussing the two theories to account for them—viz., that of a single glacier, and that of an Arctic current bearing icebergs, he decides finally in favour of the latter supposition; and he gives as his conclusion, "that all the phenomena have been produced by existing agencies, gradual in their process, and such as have been noted by different Arctic observers."—"Notes on the General Glaciation of Ireland" is a modest title for Mr. Close's paper, which we cannot but characterize as one of the most valuable communications ever made to any Geological Society. The author had shown in his previous papers his accurate powers of observation, and the

closeness of his reasoning; but this has far exceeded his former efforts. Illustrated as it is by a Map of Ireland, with the separate observations marked thereon, it forms a monograph of the glacial phenomena of our island. Mr. Close is a staunch adherent of the land-ice theory, and he has spared no time or trouble in searching out evidence to support his views, having traversed the length and breadth of the country in his explorations. In conclusion, he discusses with great fairness the reasons for and against the different theories of glaciation, and finally decides in favour of the land-ice hypothesis.

In November Mr. Wynne gave us a paper on Denudation, in which he described the facts noticed by him on the west coast of India, and compared them with those well known in Ireland. He considers, that rain and atmospheric agency have been insufficient to account for them, assigning his reasons for believing, that the action of the sea could alone be sufficient to produce the condition of the earth surface, which we now find in the districts described by him.

In December the Rev. William Robinson, of Cambridge, gave us his views of some theories to account for the climatic changes of our earth, arising from variations in the centre of its figure and gravity, communicated by the Rev. Professor Haughton, with a most able exposition of all the physical and mathematical theories on the subject; and at the last meeting Mr. Scott read a paper "on the Granitic District of Strontian, in Argyleshire"—a district visitèd by him in order to carry on the investigations in which he and Professor Haughton had been formerly engaged, with reference to the character of the granites of N. W. Ireland and of Scotland, and their relations to the circumjacent rocks.

We cannot conclude this Report without expressing the loss the Society has experienced in the resignation of Mr. R. H. Scott of his post of Honorary Secretary, which he has so ably filled for many years, and has contributed so much towards forwarding its interests, and devoted himself with such energy to its advancement. We must all, however, congratulate him on the very distinguished position he has been selected to fill, and is in every way so worthy of. Mr. Reeves has also been obliged to resign as Co-Honorary Secretary; and Professor Haughton and Mr. Macalister have kindly offered their services to fill the vacancies.

As to the financial position of the Society, we are able to congratulate the Fellows on the large increase of the subscriptions during the past year, amounting to £23 15*s*., the total amount received being £157 19*s*., of which £42 12*s*. consisted of Life Compositions; out of which £36 was invested in Government Stock, leaving £6 12*s*. to be invested. We have paid Mr. M. H. Gill, on account of printing, £58 5*s*. 6*d*., leaving a balance due to him of £61 14*s*. 3*d*. We have also received £6 12*s*. 8*d*., dividends on Government Stock, standing to our credit, which now amounts to £176 8*s*. 3*d*.; and we close our accounts with a balance in hands of £6 2*s*. 7*d*.

In the Appendix will be found, as usual :—

1st. A List of Fellows now on the books of the Society.

2nd. ,, ,, ,, gained and lost during the year.

3rd. ,, Donations received during the year.

4th. ,, Societies and Institutions to whom a copy of the "Journal" is regularly forwarded.

5th. An Abstract of the Treasurer's Account for the year 1866.

APPENDIX TO ANNUAL REPORT.

No. I.

LIST OF FELLOWS, CORRECTED TO JANUARY 31, 1867.

Fellows are requested to correct errors in this List, by letter to the Hon. Secretaries, 35, Trinity College, Dublin; or to the Assistant Secretary.

OFFICERS OF THE SOCIETY FOR THE YEAR 1867-68.

PRESIDENT.—The Earl of Enniskillen, F. R. S.

VICE-PRESIDENTS.—Alex. Carte, M. D., F. L. S.; Rev. H. Lloyd, D. D., F. R. S., Provost T. C. D.; Robert Callwell, Esq.; Joseph B. Jukes, M. A., F. R. S.; Colonel Meadows Taylor, M. R. I. A.

TREASURERS.—Gilbert Sanders, Esq.; Samuel Downing, LL. D.

SECRETARIES.—Rev. S. Haughton, M. D., F. R. S., F. T. C. D.; A. Macalister, M. D.

COUNCIL.—Sir Richard Griffith, Bart., LL. D., F. G. S.; John Kelly, Esq.; William Andrews, Esq.; Alphonse Gages, M. R. I. A.; B. B. Stoney, C. E.; Robert S. Reeves, M. A.; John Barker, M. D.; John Good, Esq.; W. B. Brownrigg, Esq.; W. Frazer, M. D., M. R. I. A.; Joseph O'Kelly, Esq.; C. P. Cotton, C. E.; Emerson J. Reynolds, Esq.; F. J. Sidney, LL. D.; with the Honorary Officers.

HONORARY FELLOWS.

Elected.

1844. 1. Boué, M. Ami, For. Mem., L. G. S., *Paris.*
1865. 2. Burton, Capt. R. F., H. M. Consul, *Santos.*
1861. 3. Daubrée, M., Membre de l'Institut, 91, *Rue de Gréville, St. Germains, Paris.*
1861. 4. Delesse, M., Ingénieur des Mines, *Paris.*
1865. 5. Des Cloiseaux, M., Prof. of Mineralogy, *Jardin des Plantes, Paris.*
1861. 6. De Serres, M. Marcel, *Montpelier.*
1861. 7. Deville, M. C. Ste Claire, *Paris.*
1861. 8. Deville, M. H. Ste Claire, *Paris.*
1861. 9. De Koninck, M. L., For. Mem., L. G. S., *Liége.*
1861. 10. Geinitz, M. H. B., For. Mem., L. G. S., *Dresden.*
1863. 11. Hunt, Dr. T. Sterry, F. R. S., *Montreal.*
1844. 12. Lyell, Sir Charles, F. R. S., 73, *Harley-street, London, W.*
1861. 13. M'Clintock, Sir Leopold, R. N., 21, *Merrion-square, North.*
1844. 14. Murchison, Sir Roderick I., F. R. S., 16, *Belgrave-square, London, S. W.*
1832. 15. Sedgwick, Rev. A., F. R. S., *Cambridge.*

HONORARY CORRESPONDING FELLOWS.

1859. 1. Gordon, John, C. E., *India.*
1859. 2. Hargrave, Henry J. B., C. E., *India.*
1859. 3. Hime, John, C. E., *Ceylon.*
1858. 4. Kingsmill, Thomas W., *Hong Kong.*
1855. 5. Medlicott, Joseph, *India.*
1854. 6. Oldham, Thomas, F. R. S., *Calcutta.*

FELLOWS WHO HAVE PAID LIFE COMPOSITION.

1853. 1. Allen, Richard Purdy, 10, *Bessboro'-terrace, N. C. Road.*
1861. 2. Armstrong, Andrew, 16, *D'Olier-street.*
1861. 3. Brown, Markham, *Connorree Mining Company, Westland-row.*
1857. 4. Carson, Rev. Joseph, D. D., F. T. C. D., *Trinity College.*
1832. 5. Davis, Charles, M. D., 33, *York-street.*

Elected.
1857. 6. Dowse, Richard, *Mountjoy-square.*
1861. 7. Fottrell, Edward, 86, *Harcourt-street.*
1862. 8. Frazer, W., M. D., M. R. I. A., 124, *Stephen's-green.*
1857. 9. Greene, John Ball, 6, *Ely-place.*
1857. 10. Haliday, A. H., A. M., F. L. S., M. R. I. A., *Harcourt-street.*
1848. 11. Haughton, Rev. Professor, M. D., F. R. S., 40, *Trinity College.*
1862. 12. Henry, F. H., *Lodge Park, Straffan, Co. Kildare.*
1850. 13. Hone, Nathaniel, M. R. A. *St. Doulough's, Co. Dublin.*
1861. 14. Hone, Thomas, *Yapton, Monkstown, County Dublin.*
1831. 15. Hutton, Robert, F. G. S., *Putney Park, London.*
1851. 16. Jukes, Joseph Beete, F. R. S., 51, *Stephen's-green.*
1834. 17. King, Hon. James, M. R. I. A., *Mitchelstown.*
1866. 18. Lalor, J. J., *Longford-terrace, Monkstown.*
1856. 19. Lentaigne, John, M. D., *Great Denmark-street.*
1848. 20. Luby, Rev. Thomas, D. D., F. T. C. D., *Trinity College.*
1851. 21. Malahide, Lord Talbot de, F. R. S., *Malahide Castle, Malahide.*
1838. 22. Mallet, Robert, C. E., F. R. S., 1, *The Grove, Clapham-road, London.*
1846. 23. Murray, B. B., *County Survey Office, Downshire-road, Newry.*
1859. 24. Ogilby, William, F. G. S., *Liscleen, Dunmanagh, Co. Tyrone.*
1849. 25. Sidney, F. J., LL. D., 19, *Herbert-street.*
1864. 26. Symes, Richard Glascott, 51, *Stephen's-green.*
1851. 27. Whitty, John Irvine, LL. D., 35, *Lower Mount-street.*

FELLOWS WHO HAVE PAID HALF LIFE COMPOSITION.*

1854. 1. Barnes, Edward, *Ballymurtagh, Co. Wicklow.*
1866. 2. Bradley, Samuel, *Little Castle, Castlecomer.*
1832. 3. Bryce, James, LL. D., F. G. S., *High School, Glasgow.*
1862. 4. Carter, T. S., *Watlington Park, Watlington, Oxfordshire.*
1854. 5. Clemes, John, *Luganure Mine, Glendalough, Co. Wicklow.*
1857. 6. Crawford, Robert, C. E., *care of Messrs. Peto and Betts*, 9, *Great George's-street, Westminster, S. W.*
1861. 7. Crosbie, William, *Ardfert Abbey, Ardfert, Tralee.*
1866. 8. Duffin, W. E. L'Estrange, *Maghera Rectory, Co. Down.*
1861. 9. Dunally, Lord, *Kilboy, Nenagh.*
1856. 10. Du Noyer, G. V., M. R. I. A., 51, *Stephen's-green.*
1832. 11. Dunraven, Earl of, F. R. S., *Adare, Co. Limerick.*
1866. 12. Ellis, R. H., *The Hill, Monkstown.*
1836. 13. Enniskillen, Earl of, F. R. S., M. R. I. A., *Florence Court, Enniskillen.*
1844. 14. Esmonde, Sir Thomas, Bart., M. R. I. A., *Johnstown Castle, Wexford.*
1866. 15. Graves, S. R., M. P., *Wavertree, Liverpool.*
1853. 16. Harkness, Professor, F. R. S., *Queen's College, Cork.*
1861. 17. Harte, W., C. E., *Buncrana, Donegal.*
1856. 18. Haughton, Lieut. John, R. A.
1850. 19. Head, Henry, M. D., 7, *Fitzwilliam-square.*
1858. 20. Hill, J., C. E., *Tullamore.*
1862. 21. Hudson, R., F. R. S., F. L. S., *Clapham Common, London.*
1865. 22. Jacob, Arthur, B. A., *Town Hall, Croydon, Surrey.*
1839. 23. James, Sir H., Colonel, R.E., F.R.S., *Ordnance Survey Office, Southampton.*

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* EXTRACT FROM BY-LAWS.

"Any person not residing for more than sixty-three days in each year within twenty miles of Dublin, shall be a Fellow for Life, or until he comes to reside within the above distance, on paying to the Treasurers the sum of £5 5s.

"Any non-resident Life Fellow who shall reside within twenty miles of Dublin for more than sixty-three days in any one year, shall cease to be a Fellow, unless he shall either pay an additional composition of £5 5s., or shall pay a subscription of 10s. 6d. for each year in which he shall so reside for more than sixty-three days."

Elected.

1832. 24. Kearney, Thomas, *Pallasgreen*, *Co. Limerick*.
1857. 25. Keane, Marcus, *Beech Park*, *Ennis*, *Co. Clare*.
1835. 26. Kelly, John, 38, *Mountpleasant-square*, *Rathmines*.
1853. 27. Kinahan, George H., 28, *D'Olier-street*.
1862. 28. Kincaid, Joseph, Jun., C. E., 9, *Spring-gardens*, *London*, *S. W.*
1838. 29. Larcom, Major-General Sir Thomas, R. E., LL. D., F. R. S., *Phœnix Park*.
1858. 30. Leech, Lieut.-Colonel, R. E., 3, *St. James's-square*, *London*, *S. W.*
1840. 31. Lindsay, Henry L., C. E., *Melbourne*, *care of J. Bower*, *Esq.*, *C.E.*, 28, *South Frederick-street*.
1840. 32. Montgomery, James E., M. R. I. A.
1856. 33. Molony, C. P., Capt., 25th Regt., Madras N. I., *per Messrs. Grinlay and Co.*, 3, *Cornhill*, *London*.
1856. 34. Medlicott, Henry B., F. G. S., *Geological Survey of India*, *per Smith and Elder*, *Cornhill*, *London*, *E. C.*
1857. 35. M'Ivor, Rev. James, *Rectory*, *Moyle*, *Newtownstewart*, *Co. Tyrone*.
1865. 36. Morton, G. H., 7, *London-road*, *Liverpool*.
1845. 37. Neville, John, C. E., M. R. I. A., *Dundalk*.
1852. 38. O'Kelly, Joseph, 54, *Stephen's-green*.
1832. 39. Renny, Henry L., R. E., *Canada*.
1865. 40. Scott, J. M., *Bengal Presidency College*, *Calcutta*.
1854. 41. Smyth, W. W., F. R. S., *Jermyn-street*, *London*.
1865. 42. Steele, Rev. W., *Portora Royal School*, *Enniskillen*.
1857. 43. Tait, Alexander, C. E., *Queen's Elms*, *Belfast*.
1832. 44. Tighe, Right Hon. William, *Woodstock*, *Innistiogue*.
1866. 45. Townsend, H. W., *Clonakilty*.
1866. 46. Wall, H. P., *Portarlington*.
1864. 47. Waller, G. A., *St. James's-gate*.
1853. 48. Webster, William B., 104, *Grafton-street*.
1861. 49. Whitney, C. J., *Brisbane*, *Queensland*.
1846. 50, Willson, Walter, 51, *Stephen's-green*.
1854. 51. Wyley, Andrew, 51, *Stephen's-green*.
1857. 52. Wynne, Arthur B., F. G. S., 51, *Stephen's-green*.

ANNUAL FELLOWS.

1861. 1. Andrews, William, *Ashton*, *Monkstown*.
1831. 2. Apjohn, James, M. D., F. R. S., *South-hill House*, *Blackrock*.
1857. 3. Bandon, Earl of, D. C. L., *Castle Bernard*, *Bandon*, *Co. Cork*.
1859. 4. Barker, John, M. B., 83, *Waterloo-road*.
1861. 5. Barrington, C. E., *Fassaroe*, *Bray*.
1862. 6. Barrington, E., *Fassaroe*, *Bray*.
1862. 7. Barton, H. M., 5, *Foster-place*.
1864. 8. Bateman, C. W., LL. B., *West End*, *Mallow*.
1859. 9. Battersby, Francis, M. D., 15, *Warrington-place*.
1844. 10. Bective, Earl of, *Headfort*, *Kells*.
1862. 11. Bennett, E., M. B., 2, *Upper Fitzwilliam-street*.
1857. 12. Bolton, George, Jun., 6, *Ely-place*.
1861. 13. Bolton, H. E., 5, *Clonskea-terrace*, *Ranelagh*.
1864. 14. Bradshaw, G. B., 38, *Sandford-road*, *Ranelagh*.
1831. 15. Brady, Right Hon. Maziere, 26, *Upper Pembroke-street*.
1861. 16. Brownrigg, W. B., *Brannockstown*, *Co. Kildare*.
1840. 17. Callwell, Robert, M. R. I. A., 25, *Herbert-place*.
1857. 18. Carte, Alexander, A. M., M. D., F. L. S., *Royal Dublin Society*.
1862. 19. Close, Rev. Maxwell, *Newtownpark*, *Blackrock*.
1858. 20. Cotton, Charles P., C. E., 11, *Lower Pembroke-street*.
1862. 21. Cousins, A. L., C. E., 60, *Harcourt-street*.
1834. 22. Croker, Charles P., M. D., 7, *Merrion-square*, *West*.
1863. 23. Crook, Rev. R., LL. D., 2, *St. John's-road*, *Sandymount*.
1853. 24. De Vesci, Lord, *Abbeyleix House*, *Abbeyleix*.
1863. 25. Dixon, G., 32, *Holles-street*.

Elected.
1849. 26. Downing, Samuel, C. E., LL. D., 6, *Trinity College.*
1852. 27. Doyle, J. B., *Derrymore House, Newry.*
1866. 28. Edgeworth, D. B., C. E., *Kildare street Club.*
1865. 29. Fleming, John M., *Royal Engineers' Department, Royal Barracks.*
1866. 30. Foot, A. W., M. D., *Upper Pembroke-street.*
1858. 31. Gages, Alphonse, M. R. I. A., 51, *Stephen's-green.*
1864. 32. Gahen, A., C. E., *Omagh.*
1849. 33. Galbraith, Rev. Joseph A., F. T. C. D., *Trinity College.*
1865. 34. Gibson, John, C. E., *Stapleton-place, Dundalk.*
1865. 35. Gray, R. A., C. E., 5, *Palmerston Villas, Upper Rathmines.*
1859. 36. Green, Murdock, 52, *Lower Sackville-street.*
1862. 37. Gribbon, C. P., 72, *Stephen's-green.*
1831. 38. Griffith, Sir R., Bart., LL. D., F. G. S., 2, *Fitzwilliam-place.*
1856. 39. Good, John, *City-quay.*
1857. 40. Hampton, Thomas, C. E., 6, *Ely-place.*
1866. 41. Harold, W. J., *Ormond-quay.*
1866. 42. Heron, Robert, *Ormond-quay.*
1861. 43. Hudson, A., M. D., *Merrion-square.*
1865. 44. Hutton, T. M., 118, *Summer-hill.*
1852. 45. Jellett, Rev. Professor, F. T. C. D., M. R. I. A., 9, *Trinity College.*
1842. 46. Jennings, F. M., M. R. I. A., F. G. S., *Brown-street, Cork.*
1862. 47. Kinahan, G., J. P., *Roebuck-hill, Dundrum.*
1866. 48. Knapp, W. H., C. E., 6, *Belgrave-square, Monkstown.*
1865. 49. Leech, John, C. E., 6, *Ely-place.*
1831. 50. Lloyd, Rev. Humphrey, D. D., F. R. S., Provost T. C. D., *Provost's House.*
1863. 51. Macalister, A., M. D., 10, *Gardiner's-place.*
1855. 52. M'Causland, Dominick, 12, *Fitzgibbon-street.*
1866. 53. M'Clintock, A.. M. D., 21, *Merrion-square, North.*
1861. 54. M'Comas, A., 23, *Rathmines-road.*
1865. 55. M'Donnell, Alexander, C. E., *St. John's, Inchicore.*
1851. 56. M'Donnell, John, M. D., 4, *Gardiner's-row.*
1837. 57. Mollan, John, M. D., 8, *Fitzwilliam-square.*
1859. 58. Moore, Joseph Scott, J. P., *Hume-street.*
1831. 59. Nicholson, John, M. R. I. A., *Balrath House, Kells.*
1856. 60. O'Brien, Octavius, 23, *Kildare-street.*
1865. 61. Ollis, G., *The Camp, Aldershott.*
1864. 62. Palmer, Sandford, *Roscrea.*
1865. 63. Porte, G., *Beggarsbush-road.*
1857. 64. Porter, William, C. E., *Leinster Club, Clare-street.*
1865. 65. Radley, John, *Gresham Hotel, Sackville-street.*
1864. 66. Reynolds, Emerson J., *Royal Dublin Society.*
1857. 67. Reeves, R. S., 22, *Upper Mount-street.*
1861. 68. Roberts, W. G., *Ballinapark, Ovoca.*
1862. 69. Rowan, D. J., C. E., *Dundalk.*
1864. 70. Russell, H., *Simmon's-court.*
1852. 71. Smith, Robert, M. D., 63, *Eccles-street.*
1852. 72. Sanders, Gilbert, M. R. I. A., *The Hill, Monkstown.*
1854. 73. Scott, Robert H., F.G. S., *Meteorological Office*, 2, *Parliament-street, London.*
1864. 74. Scovell, F., *Blackrock.*
1866. 75. Stewart, H., M. D., *Lucan.*
1859. 76. Stokes, William, M. D., F. R. S., 5, *Merrion-square, N.*
1861. 77. Stoney, Bindon, C. E., 42, *Wellington-road.*
1862. 78. Taylor, Colonel Meadows, M. R. I. A., *Old-court, Harold's-cross.*
1864. 79. Tichbourne, C. R. C., *Apothecaries' Hall, Mary-street.*
1862. 80. Trench, W. R., *University Club, Stephen's-green.*
1859. 81. Waldron, L., LL. D., *Ballybrack, Dalkey.*
1863. 82. Westropp, W. H. S., M. R. I. A., 2, *Idrone-terrace, Blackrock.*

Elected.
1863. 83. Williams, R. P., 38, *Dame-street.*
1851. 84. Wright, Edward, LL. D., M. R. I. A., *Floraville, Donnybrook.*
1864. 85. Wright, Joseph, 39, *Duncan-street, Cork.*

ASSOCIATES FOR THE YEAR.

1. Atkins, William, 18, *Trinity College.*
2. Backhouse, M., 2, *Ontario-terrace.*
3. Eiffe, L., *Bray.*
4. Moore, J. H., 13, *Trinity College.*
5. Phelan, A., 16, *do.*
6. Wynne, E., 17, *do.*

No. II.

LIST OF FELLOWS GAINED AND LOST,

During the Year ending January 31, 1866.

FELLOWS GAINED.

Honorary.

Nil.

Life.

1. Lalor, J. J., *Longford-terrace, Monkstown.*

Half Life.

1. Bradley, Samuel, *Little Castle, Castlecomer.*
2. Duffin, W. E. L'Estrange, *Maghera Rectory, Co. Down.*
3. Ellis, R. H., *The Hill, Monkstown.*
4. Graves, S. R., M. P., *Wavertree, Liverpool.*
5. Townsend, H. M., *Clonakilty.*
6. Wall, H. P., *Arlington House, Portarlington.*

Annual.

1. Edgeworth, D. B., C. E., *Kildare-street Club.*
2. Foot, A. W., M. D., *Upper Pembroke-street.*
3. Harold, W. J., *Ormond-quay.*
4. Heron, Robert, *Ormond-quay.*
5. Knapp, W. H., C. E., 6, *Belgrave-square, Monkstown.*
6. M'Clintock, A., M. D., *Merrion-square, North.*
7. Stewart, H., M. D., *Lucan.*

FELLOWS LOST.

Half Life.

1. Clarke, Edward, M. D., *Rathmines.* Deceased.
2. Foot, Frederick J., 51, *Stephen's-green.* Do.

Annual.

1.	Baily, W. H., F. G. S., 51, *Stephen's-green.*	Resigned.
2.	D'Arcy, Matthew, *Ussher-street.*	Do.
3.	Frith, R. J., *Rathmines.*	Do.
4.	Hutton, Thomas, F. G. S., *Summer-hill.*	Deceased.
5.	Johnston, C. F., 9, *Eustace-street.*	Do.
6.	Mac Donnell, Rev. Richard, *Trinity College.*	Do.
7.	Moore, Stephenson C., *Rathgar.*	Resigned.
8.	Ormsby, M. H., 16, *Fitzwilliam-square.*	Do.
9.	Walker, William F., 9, *Trinity College.*	Do.

Removed from List, for Non-payment of Subscription.

1. Garnett, G. C., 5, *Mountjoy-square, North.*

State of the Society at the commencement of—

	Year 1866.	Year 1867.
Honorary Fellows,	15	15
Corresponding do.,	6	6
Life do.,	74	79
Annual do.,	88	85
	183	185

No. III.

DONATIONS RECEIVED TO JANUARY 31, 1867.

Amsterdam.—Kon. Akademie van Wettenschapen, Verslagen en Mededeelingen, Second Series, Vol. I.

——— Processen Verbal, 1865–6.

——— Jaarboek, 1865.

——— Catalogus Boekeri, Part 2, Vol. I.

Berlin.—Deutsche Geologische Gesellschaft, Zeitschrift, Vol. XVII., Parts 3, 4; XVIII., Parts 1, 2.

——— Zeitschrift der Gesellschaft für Allgemeine Erdkunde, Nos. 2–5.

Bologna.—Accademia delle Scienze dell' Istituto, Memorie, Tom IV., Parts 2–4; Tom V., Parts 1, 2.

——— Rendiconto delle Sessione, 1864–5.

Boston.—Natural History Society. Proceedings, Vol. X.; 1–18.

———Annual Reports, Vol. I., 1865.

Bremen.—Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine. Vol. I., Part 1.

Brussels.— Academie Royale, Annuaire, 1866.

——— Bulletin, Vols. XX., XXI.

Caen—Société Linnéenne de Normandie, Bulletin, Vol. X., Part 1.

Cambridge, U. S. A.—Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College. 1865.

Canada.—Geological Survey of, Atlas of Maps and Sections. From Viscount Monck, Governor-General.

Dresden.—Sitzungsberichte der Naturwissenschaftlichen Gesellschaft, Isis, Nos. 7-9.

Dublin.—The Dublin Quarterly Journal of Science, Nos. 21–24. From the Editor, Rev. Samuel Haughton, M. D.

——— Royal Dublin Society, Journal, No. 34.

Dublin.—Explanations to the Sheets of the Geological Survey of Ireland, 117, 118. From Sir R. Murchison, Director-General.
Glasgow.—Geological Society, Transactions, Vol. II., Parts 1, 2.
Haarlem.—Archives Neerlandaises des Sciences exactes et naturelles. Vol. I., Parts 1, 2.
——— Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen. Vol. XXI., Part 2; XXII., 1-2.; XXIII.
Halle.—Naturwissenschaftliche Verein für Sachsen und Thüringen in Halle. Zeitschrift für die gesammten Naturwissenschaften. Vol. XXVI.
India.—Geological Survey, Memoirs of. Vol. IV., Part 3; V., Part 1.
——————— On the Geology of Bombay.
—— Annual Report, 1864-5.
—— Catalogue of Echinodermata.
—— Palæontologia Indica, Vol. III., Parts 6-9; IV., Part. 1.
Kilkenny.—Kilkenny and South-East of Ireland Archæological Society, Proceedings and Papers. Vol. V., Nos. 49-51.
Leipsic.—K. Sächsische Gesellschaft der Wissenschaften, Abhandlungen. Vol. VII., 2-4; VIII., 1.
——— Berichte über die Verhandlungen, 1864.
Leeds.—The Geological and Natural History Repertory, Nos. 10-12.
——— Philosophical and Literary Society, Annual Reports, 1864-5.
——— Catalogue of Library, 1866.
Liverpool.—Historic Society of Lancashire and Cheshire, Transactions, 1865. Vol. V.
——— Geological Society, Proceedings, 1865-66.
Lausanne.—Société Vaudoise des Sciences Naturelles, Bulletin, Vol. VIII., 53; Vol. IX., 54.
London.—Geological Society, Quarterly Journal, Parts 85-89.
——— Royal Geographical Society, Journal, Vol. XXXV.
——————————— Proceedings, Vol. X., Parts 2-6.
——— Royal Society, Proceedings, Nos. 79-87.
——— British Association Report, 1865.
——— Linnean Society, Journal of Proceedings, Vol. IX., No. 36.
—————— Botany, Vol. IX., Part 38.
—————— Zoology, Vol. IX., Parts 33-35.
——— Zoological Society, Proceedings, 1865. Parts 1, 2, 4.
—————— Report of Council, 1866.
——— Geologists' Association, Annual Report, 1866.
——— Institution of Civil Engineers, Minutes of Proceedings. Vols. XXII. to XXV.
——————————————— Library Catalogue.
Manchester.—Literary and Philosophical Society, Memoirs, 3rd Series. Vol. II. Proceedings, Vols. III,. IV.
——— Geological Society, Transactions, Vol. V., Parts 14-17.
Milan.—Reale Istituto Lombardo de Scienze, Rendiconti, Vol. II., Parts 3-8.
—————— Memorie, Vol. X., Part 2.
—————— Lettere. Vol. II., Parts 3-7.
Montreal.—Natural History Society, The Canadian Naturalist and Geologist, Vol. II., Parts 5, 6.
Munich.—K. Baierische Akademie der Wissenschaften, Sitzungs-berichte, 1865. Vol. II., Parts 3, 4.
Neuchatel.—Bulletin de la Société des Sciences Naturelles. Vol. VII., Parts 1, 2.
Newhaven.—The American Journal of Science and Art, Nos. 121-123, 125. From the Editors.
New York.—Lyceum of Natural History, Annals. Vol. VIII., Parts 4-10.
Philadelphia.—American Philosophical Society, Proceedings, Vol. X., Parts 74, 75.
—————— Catalogue of Library, Part 2.
—————— Transactions, Vol. XIII., Part 2.
Plymouth.—The Institution, Report of the Transactions, 1865-66. Vol. II., Part 1.

St. Petersburgh.—Kaiserliche Gesellschaft für die Gesammte Mineralogie. Verhandlungen, 1863.
St. Louis.—Academy of Science, Vol. II., No. 2.
Stockholm.—K. Vetenskaps Akadamiens Forhandlingar. Ofversigte.
Strasburg.—Mémoires de la Société des Sciences Naturelles, Vol. VI.
Sweden.—Geological Survey of, Maps, Parts 1-18, with Explanations.
Toronto.—Canadian Institute. The Canadian Journal of Industry, Science, and Art. Nos. 61-63.
Stuttgart.—Verein für Vaterländische Naturkunde. Würtembergische Naturwissenschaftliche Jahreshefte, 1865. 1-3.
Vienna.—K. K. Geologische Reichsanstalt, Jahrbuch. Vol. XII., Part 4; XIII., Part 4; XIV., Part 3; XV., Part 4; XVI., Part 1. From the Director, Prof. Haidinger.
——— K. K. Zoologisch-Botanische Gesellschaft, Verhandlungen, 1865-66.
Washington.—Smithsonian Institution, Report, 1864.
Yorkshire.—Geological and Polytechnic Society of the West Riding of, Report, 1864-5.

PRESENTED BY THE AUTHORS.

Baily, W. H.—The Cambrian Rocks of the British Islands, with especial reference to the Occurrence of the Formation and its Fossils in Ireland.
Davis, J. B.—On Synostotic Crania among Aboriginal Races of Men.
Geinitz, H. B., and Liebe, Dr. K. H.—Ueber ein Æquivalent der takonischen Schiefer Nordamerikas in Deutschland und dessen Geologische Stellung.
Hansen, P. A.—Relation zwischen Summen und Differenzen.
Jervis, W. P.—The Mineral Resources of Central Italy, including a Description of the Mines and Marble Quarries.
——— Official Catalogue of the International Exhibition, Kingdom of Italy, 1862.
Marsh, O. C., M. A.—Description of an Ancient Sepulchral Mound, near Newark, Ohio.
Page, D., F. G. S.—Addresses on "Geology and Modern Thought," "Present Position and Future Prospects of Geological Inquiry."
Pictet, F. J., and Humbert. A.—Nouvelles Recherches sur les Poissons Fossils du Mont Liban.
Winchell, Prof. A.—Enumeration of Fossils collected in the Niagara Limestone at Chicago, with Description of several New Species.
——— Description of New Species of Fossils from the Marshall Group of Michigan, with Notes of some Fossils of the same Age, previously described.
——— On the Drift of Michigan.
——— On the Prairies of the Mississippi Valley.
——— Notes on *Selandria Cerasi*, Harris.
Wood, S. V.—Remarks in Explanation of the Map of the Upper Tertiaries of the Counties of Norfolk, Suffolk, Essex, Middlesex, Hertford, Cambridge, Huntingdon, and Bedford, with part of those of Buckingham and Lincoln, and accompanying sections.

No. IV.

SOCIETIES AND INSTITUTIONS TO WHICH THE JOURNAL OF THE ROYAL GEOLOGICAL SOCIETY OF IRELAND IS SENT.

ABERDEEN, .	University Library.
ALBANY, . .	State Library, New York.
AMSTERDAM, .	Royal Academy of Sciences.
ANTWERP, .	Société Palæontologique de Belgique.
BELFAST, . .	Queen's College Library.
BERLIN, . .	Royal Academy of Sciences.
	German Geographical Society.
	German Geological Society, per Besserche Buchhandlung, *Behren-str.*, 7, *Berlin*.
BOLOGNA, .	Accademia delle Scienzi dell' Istituto.
BORDEAUX, .	Imperial Academy of Sciences.
BOSTON, . .	American Academy.
	Natural History Society.
BRISTOL, . .	Institution for the Advancement of Science, Literature, and the Arts.
BRÜNN, . .	Naturforschende Verein.
BRUSSELS, .	Academy of Sciences.
CAEN, . . .	Société Linnéenne de Normandie.
CALCUTTA, .	Asiatic Society.
	Public Library.
	Geological Survey of India.
CAMBRIDGE, .	Philosophical Society.
	Trinity College Library.
CANTERBURY, NEW ZEALAND,	Geological Survey.
COPENHAGEN,	Royal Society of Science.
CORK, . . .	Queen's College Library.
	Royal Institution.
DIJON, . . .	Academy of Sciences.
DRESDEN, . .	The "Isis" Society.
DUBLIN, . .	Royal College of Surgeons' Library.
	Royal Irish Academy.
	University Library.
	Royal Dublin Society.
	Natural History Society.
	Ordnance Survey Library.
	Professor Sullivan, as Editor of the "Atlantis."
	Geological Survey of Ireland.
	Institution of Civil Engineers.
EDINBURGH, .	Royal Society.
	Wernerian Society.
	Royal Scottish Society of Arts.
	University Library.
	Society of Antiquaries.
	Advocates' Library.
FALMOUTH, .	Royal Cornwall Polytechnic Society.
FLORENCE, .	Society of Physics and Natural History.
GALWAY, . .	Queen's College Library.
GENOA, . .	Society of Physics.
GLASGOW, . .	University.
	Geological Society.
GÖTTINGEN, .	University.
HAARLEM, .	Société Hollandaise des Sciences, per B. Quarritch, 15, *Piccadilly*, *London*.

HALLE, . . Naturwissenschaftliche Verein für Sachsen und Thüringen, per Antons Buchhandlung, *Halle*.
HANAU, . . Oberhessische Gesellschaft der Natur-und Heil-kunde.
HANOVER, . Royal Library.
KILKENNY, . Archæological Society.
KÖNIGSBERG, Königlich Physikalisch-Oekonomische Gesellschaft.
LAUSANNE, . Société Vaudoise des Sciences Naturelles.
LEEDS, . . Geological and Polytechnic Society of the West Riding of Yorkshire.
Philosophical and Literary Society.
LEIPZIC, . . Royal Society of Sciences (Saxony).
University.
LIVERPOOL, . The Literary and Philosophical Society.
Historic Society of Lancashire and Cheshire.
Geological Society, The Royal Institution, *Colquitt-street*.
LONDON, . . Geological Survey, *Jermyn-street*.
British Museum.
Society of Arts, *John-street*, *Adelphi*.
Royal Institution, *Albemarle-street*.
Royal Society, *Burlington House*.
Geological Society, *Somerset House*.
Linnean Society, *Burlington House*.
Royal Geographical Society, 15, *Whitehall-place*.
Civil Engineers, Institution of, 25, *Great George's-street*, *Westminster*.
Royal Asiatic Society, 5, *New Burlington-street*.
Royal College of Surgeons, *Lincoln's Inn*.
Zoological Society, 11, *Hanover-square*.
Athenæum, 14, *Wellington-street*, *Strand*, *London*, *W. C.*
Anthropological Society, 4, *St. Martin's-place*, *London*, *W. C.*
LYONS, . . La Société Impériale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles.
Société Linnéenne.
. Academie Impériale, per Treuttel & Würtz, 19, *Rue de Lille*, *Paris*.
MADRID, . . Academia de Ciencias.
MANCHESTER, Literary and Philosophical Society of. [Sec., R. C. Christie.]
Geological Society.
MELBOURNE, . Philosophical Institute of Victoria.
The Public Library, per Bain and Co., 1, *Haymarket*, *London*.
The Royal Society.
MILAN, . . Reale Istituto Lombardo di Scienzi.
MISSOURI, . . State Survey and University, *Geological Rooms*, *Columbia*, *U. S. A.*
MODENA, . . Institute of Science.
MONTREAL, . Natural History Society.
MUNICH, . . Royal Academy of Science (2 copies).
NEUCHATEL, . Société des Sciences Naturelles.
NEWHAVEN, U. S. A., } The Editors of Silliman's Journal of Science and Art.
NEW YORK, . Lyceum of Natural History.
OXFORD, . . Bodleian Library.
Ashmolean Society.
PALERMO, . Accademia di Scienzi e Lettere.
PARIS, . . Ecole Polytechnique.
Geological Society.
L'Ecole Impériale des Mines.
Institute of France.
Bibliothéque Impériale.
Jardin des Plantes, Bibliothéque.
PHILADELPHIA, American Philosophical Society.
Academy of Natural Sciences, per Trübner and Co.
PLYMOUTH, . Plymouth Institution and Devon and Cornwall Natural History Society.

PRESBURG, .	Verein für Naturkunde.
QUEBEC, . .	Literary and Historical Society.
ROME, . . .	The Vatican Library.
ROUEN, . .	Academy of Sciences.
ST. ANDREWS,	University Library.
ST. LOUIS, . .	Academy of Sciences.
ST. PETERSBURG,	Imperial Academy.
	Central Physical Observatory of Russia.
	Russisch-Kaiserliche Mineralogische Gesellschaft.
STOCKHOLM, .	Royal Academy of Science, per Longman and Co., *Paternoster-row, London*; and Sampson and Wallis, *Stockholm*.
	Geological Survey of Sweden.
STRASBOURG,	Société des Sciences Naturelles.
STUTTGART, .	Verein für vaterländische Naturkunde.
TORONTO, C. W.,	Canadian Institute, per Thomas Henning, Esq.
TOULOUSE, .	Academy of Sciences.
TRURO, . .	Royal Institute of Cornwall.
TURIN, . .	Royal Academy.
UPSALA, . .	Royal Society of Sciences.
VIENNA, . .	Imperial Academy of Sciences.
	Prof. W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichs-anstalt."
	K. K. Zoologisch-botanische Gesellschaft, per Braumüller and Co., *Vienna*.
WASHINGTON,	Smithsonian Institute Library, per W. Wesley, Esq., 2, *Queen's Head, Passage, Paternoster-row, London, E. C.*
WINDSOR, .	The Royal Library.
ZURICH, . .	Naturforschende Gesellschaft.

No. V.

ABSTRACT OF TREASURER'S ACCOUNT FOR THE YEAR ENDED DECEMBER 31, 1866.

1866.—Dr.	£	s.	d.	£	s.	d.
To Balance from last year's Account, ...				5	17	2
— Amount of Subscriptions received for year ending December 31, 1866, viz.—						
— Life Compositions, ...	£42	12	0			
— Entrance Fees, ...	7	7	0			
— Annual Subscriptions, ...	108	0	0			
				157	19	0
— Amount of Dividend for one half-year on Government Stock, viz.						
October 31, 1865, on £134 7 8 . .	2	0	4			
April 30, 1866, on 134 7 8 . .	2	0	4			
October 31, 1866, on 176 8 8 . .	2	12	0			
				6	12	8
— Cash received by sale of Catalogues, ...				1	2	0
				£171	10	10

1866.—Cr.	£	s.	d.	£	s.	d.
By W. J. Galbraith, on account of Petty Cash, . . .				5	0	0
— Eaton and Co., Stationery, ...	£2	2	0			
— Messrs. Williams and Co., Carriage of Books, ...	2	1	10			
— Ward and Co., filling Diplomas, . . .	0	18	6			
— Hodges and Co., Ironmongery, . . .	0	2	0			
				5	4	4
— Invested in Government Stock, ...				26	0	0
— Assistant Secretary, Petty Cash, as per Book, . .				5	0	0
— M. H. Gill, on Account of Printing, ...				25	0	0
— Assistant Secretary, Petty Cash, as per Book, . .				5	0	0
— Ditto, ditto, ditto, ...				5	0	0
— Invested in Government Stock, ...				10	0	0
— Assistant Secretary, Half-year's Salary, ...				10	0	0
— M. H. Gill, for sundry Printing, ...				5	16	0
— Eaton and Co., Stationery, ...	£0	19	0			
— M. Ward and Co., filling Diplomas, . .	0	18	6			
— Foster and Co., for Printing, &c., . . .	4	0	11			
				5	18	5
— Assistant Secretary, Petty Cash, as per Book, . .				5	0	0
— M. H. Gill, for sundry Printing, ...				7	9	6
— Ditto, ditto, on account, ...				20	0	0
— Assistant Secretary, Petty Cash, as per Book, . .				10	0	0
— Assistant Secretary, Half-year's Salary, ...				10	0	0
— Ditto, Petty Cash, as per Book, ...				5	0	0
				£165	8	3
— Balance in Bank, ...	3	14	4			
— Ditto, in Treasurer's hands, ...	2	8	3			
				6	2	7
				£171	10	10

We have examined the foregoing Account, and compared vouchers, and find that a balance remains to the credit of the Society of £6 2*s.* 7*d.*

Audited February 6, 1867.

(Signed) SAMUEL HAUGHTON.
JOHN GOOD.

MINUTES OF PROCEEDINGS FOR THE YEAR 1866-67.

General Meeting, March 14, 1866.

Robert Callwell, Esq., in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

Mr. W. H. Westropp read Mr. G. H. Kinahan's paper on "Some of the Drift in Ireland" (p. 191.)

Mr. Close read his paper, "Notes on the General Glaciation of Ireland" (p. 207.)

Mr. Scott proposed, and Dr. Bennett seconded a vote of thanks to Mr. Close for his valuable paper, and for the clear demonstration of his views which he had laid before the meeting."

Resolved:—"That the discussion on Mr. Close's paper be postponed until the next meeting.

The meeting then adjourned.

General Meeting April 11, 1866.

J. Scott Moore, J. P., D. L., in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

Mr. Close read an abstract of his paper read at the last meeting, the discussion on which was postponed by resolution of the Society.

Professor Haughton observed that the paper had been one of the most important ever brought before the Society, as it reduced to a certain law the various observations recorded through Ireland of so-called glacial striations. Mr. Close gave proofs of a general scoring from N. W. to S. E., agreeing with the observations of transatlantic geologists; and it would appear that the local variations from this direction which had been observed were subsequent to the original striations; *e. g.*, from his own observations at Kenmare, the striations were parallel to the valley, but the general striations were transverse to that direction. He agreed with Mr. Close in the idea that the glacial action was not referrible solely to local action due to the present position of mountain chains, but to some more general causes affecting the whole of the island. What was that cause? We have no proof of the existence of a continent to the N. W. of Ireland, as the Atlantic is very deep there, and has been so for times long anterior to those now under consideration. The sea between Africa and Cape St. Roque was much shallower than the North Atlantic. Would not a south current such as flows out of Baffin's Bay account for the phenomena, which would then be due to floating ice? The hypothesis of a continent to the N. W. would suppose that land existed in a sea which was at present three miles deep; and Professor Haughton now laid before the Society some results obtained by the assistance of Admiral Ervingen, of the Danish Marine, who had had observations made on the coast of Greenland by Mr. Asbo, a Missionary, near Cape Farewell, and from which it would appear that the mean depth of the whole Atlantic Ocean down to the South Pole, including the shallow at Cape St. Roque, was 3·30 miles; so that he did not consider there was any proof of the former existence of a continent situated in the centre of the present Atlantic Ocean.

Mr. Du Noyer confirmed the statements that local striations were transverse to the main markings, but agreed with Professor Haughton that the striations were not due to glacier ice, as there was no proof of the existence of land to account for this.

Dr. Macalister confirmed Mr. Close's result from observations of his own, in Skye and Mull, and from some which he had received from Stromness, in the Orkneys, all proving a current from N. W. to S. E.: he agreed with the last two speakers, that the ice was not glacier ice. The shells found at Stromness and at Thurso, in the drift, were marine.

Hugh Miller thought that the drift was formed by floating ice, the dressing of the rocks proceeding from below upwards. Mr. Cumming, in the Isle of Man, had quoted a boulder carried from the N. W., but raised to a level of 700 feet above its original position.

Mr. Scott and Mr. Westropp made some observations as to the probability of the striation having been caused by land ice. Mr. Close, in reply, stated that the idea of a Tertiary Atlantic Continent had been mooted, and might account for the land to the N. W. of this country. He agreed with the last speakers that fixed ice was probably the agent.

Mr. Bolton read his paper on "Slickensides observed in the Island of Arran" (p. 242).

Mr. Du Noyer was glad to hear that Mr. Bolton was induced to separate the two classes of Slickensides—those caused by motion, and those due to crystallization. As to the former, a very slight motion was sufficient to cause the appearance, as was proved by the facts observed in the working of the machine for making compressed turf by Mr. Hodgson's process.

Mr. Du Noyer read his "Notes on the Discovery of a Megaceros near Kilskeer, county of Meath" (p. 247).

The meeting then adjourned.

General Meeting, May 9, 1866.

Mr. J. Scott Moore, D. L., J. P. in the Chair.

The minutes of last meeting were read, compared, and signed; donations announced, and thanks voted.

Mr. O'Kelly read a short notice, introductory to the Exhibition of some Fossil Foraminifera from the Tertiary beds of Malaga.

Mr. Baily gave a description of the Fossils.

Mr. Scott read a "Notice of the Occurrence of some Felstone, Ash, and Trap in the Curlew Hills, Co. Sligo," by Messrs. Jukes and Foot (p. 249).

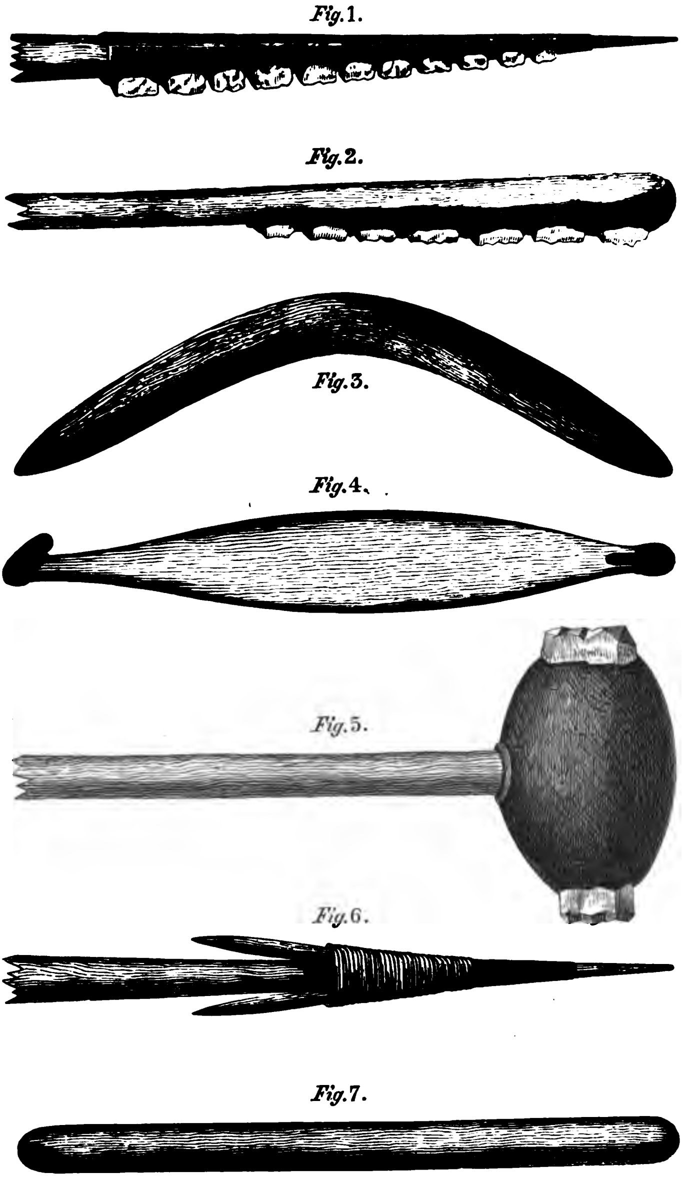
Professor Haughton exhibited to the meeting four stone implements, found imbedded in magnetic iron gravel, or semi-consolidated "laterite," in the valley of the Soornamookey River, near Kircumbody, North Arcot district, Madras; and presented to the Museum of Trinity College by T. H. Going, C. E.

These specimens, which are of large size, and of the rudest workmanship, are made of a coarse yellowish quartzose grit, and must have formed the weapons of men in the rudest possible state of culture. The "laterite" in which they were found imbedded is generally regarded as the equivalent of European "drift;" but there is no evidence to show that the weapons were of the same age as the magnetic iron gravel in which they were found.

Professor Haughton exhibited also a number of quartz, jasper, and flint arrow heads of old Creek and Choctaw manufacture, found in Central Alabama; and presented to the Museum of Trinity College by Professor J. W. Mallet.

In connexion with the interesting question of the probable age of the so-called "Stone Period," Professor Haughton read the following communication from Mr. G. F. Moore, who has spent a large portion of his life in Western Australia:—

"Much interest has been excited lately on the subject of the history of what is called the 'Stone Period,' and doubts even have been entertained as to the possibility of human beings sustaining life without the use and assistance of metals to a greater or less extent; but the aborigines of Australia furnish a living instance of a race who even at this day, in their savage state, are wholly without the use of metals of any sort. I can speak with confidence of that portion of those people of whose ways and habits I had much experience during many years; so that I can assert that at the time of our first coming regularly and systematically into contact with that people, about the year 1830, the natives of the south-western part of Australia had not even the slightest knowledge of any kind of metal. There is not a name for such in their language, and their only idea of such a substance was, that it was a hard sort of stone; yet they have wea-



TO ILLUSTRATE MR. MOORE'S LETTER RESPECTING THE STONE IMPLEMENTS USED BY THE ABORIGINES IN WESTERN AUSTRALIA.—(See Vol. I., p. 284.)

pons, and some tools—they have spears, knives, hatchets, projectiles, skewers, and also implements for loosening and shovelling out earth. One sort of spear, called 'Gidji Boryl,' having a serrated edge, formed of chips of quartz, is most formidable in war; another sort, called 'Gidji Garbel,' armed with a wooden barb, is most effective for the destruction of game. They have no vessels capable of holding any liquid, not even a shell, a gourd, or a joint of bamboo, much less of metal; no means of cooking food by boiling or heating water; no implement for cultivation, yet they can loosen the earth with a long stick, shaped at the end like a crowbar, and, in digging for water, can shovel out the earth by a piece of hardened bark. Their hatchet, called 'Kadjo,' is formed merely by cementing two pieces of stone to the end of a short stick; and such is the tenacity of this cement that I never saw an instance of its giving way, yet with the blunter end they break the hardest bones, and with the sharper end they cut deep notches in the bark, by means of which they can climb the largest and tallest trees, assisting themselves by the spike-shaped end of the handle of the hatchet. The serrated edge of the war-spear, as well as the serrated edge of the knife, called 'Dappa,' were formed of small chips of quartz, struck off from the lump by the aid of their hammer, and are fastened also by cement. Since we came among them they have learned to chip pieces of glass from a bottle, instead of the chips of quartz; they find the glass more cutting, and more easily shaped, and therefore they now prefer it. Nevertheless, in remote places, and in their savage state, they are a people, as I said at first, living even now in a state which may be truly described as a 'Stone Period'" (May 2, 1866). The cement with which these stone implements are attached to their handles is the sap of the *Xanthorrhœa hastilis*.

Messrs. Macalister, Close, Scott, and the Chairman joined in the discussion.

The meeting then adjourned.

GENERAL MEETING, JUNE 13, 1866.

PROFESSOR HAUGHTON, in the Chair.

The minutes of last meeting were read, compared, and signed; donations announced, and thanks voted.

The ballot for new Fellows was declared open.

Dr. Carte and Mr. Good were appointed scrutineers.

The Chairman drew the attention of the Fellows to the fact, that this Society had not been hitherto represented at the meeting of the British Association, and he accordingly would proceed, with the approbation of the meeting, to nominate three Fellows; viz:—Professor Jukes, Rev. M. Close, Mr. J. J. Lalor, who would attend the meeting, in order to act as the representatives of the Society at the meeting in Nottingham. This proposal was unanimously adopted.

Mr. S. J. Scott Moore read his paper on "a Specimen of Granite, exhibiting Spheroidal Structure, from Cloghlea, County of Wicklow; and on the Discovery of an Ancient Stone Hatchet" (p. 250); and also read a letter from his brother, relative to an oval stone, which he exhibited:—

"57, SLOANE-STREET, LONDON, *March* 31, 1866.

"DEAR JOSEPH,—On the spur of the moment, I give you all that I can now recall to mind of the history of the 'Oval Aërolite.'

"About twenty-five years ago, Weenat, an intelligent youth of the Aboriginal race of Western Australia, told me that he knew and would show me where there was a number of stones that were said by the natives to have fallen from the sky long ago. It was this same Weenat who once sung the first part of 'Ye banks and braes,' and when I asked for the second part replied—'no other one roundabout—far away go can't get him.' He said that these stones were carefully placed on the ground, arranged like the eggs in a bird's nest—that from time to time they were taken up and arranged afresh on the surface, so that they should not at any time be either wholly or partially

covered by any chance accumulation of earth. He led me up a valley among the hills, two or three miles from my own country house at Millendon, on the banks of the Swan River; and there I found the nest, as he had described it, having perhaps about twenty stones, of various shapes and sizes, disposed so as to form a circle of about two feet in diameter. The stones had all a peculiar glossy look on the outside, but were by no means of the same colour or character—some being like granite, some like compact hard sandstone, some like basalt; but one, in particular, was very remarkable in shape, colour, and appearance. This one was placed in the centre, and was so exactly like a magnified egg of an Emu, that the similitude was startling. The shape was oval, as perfect as that of the egg itself; the colour was of the same peculiar shade of dark olive green, and the outside had the same polished yet not quite smooth surface which characterizes the natural full-sized egg of the Emu. That stone is (probably) now before you, and any person who has ever seen an egg of that bird will at once perceive the resemblance. In the colony the invariable exclamation of any one who saw the stone for the first time was, 'What an enormous Emu's egg! where did you find such an egg as that?' You will observe that it is very heavy, and therefore will not be surprised to find that, although I was riding, yet not being provided with any basket, or other such means of conveyance, I was not able to carry away more than two in my hands. The native could not, or would not, carry any such weight. I have never had it in my power to visit that spot again. I came to England on a short leave of absence soon afterwards, and brought the specimen with me to this country.

"Now comes the question, 'What is it?' I have no other authority to give for its being an aërolite than the mere assertion of the tradition so communicated to me, namely that the *yoong-ar* (natives) all say that these stones fell from the sky; that they treat them with care and reverence, as testified by their placing them together in the circular form, as in a nest; and by their anxiety to preserve them from being soiled or covered with earth. On the subject of their reverence for stones I may here mention that on one occasion, in the course of an exploring expedition, we passed near a tall standing stone called 'Boyé Gogomat,' the Gogomat stone. A native who accompanied us broke off an armful of the rush-like leaves of a Xanthorrhœa, and strewed them round the stone, to make, as he said, a bed for the Gogomat. I could get no other explanation of the act than that they always did so. But, to return to the aërolite—it differs totally from any rock in the neighbourhood; indeed, from any rock that I have ever seen in Australia. The basis of all the hills round about is a grey granite; there are also pieces of what is colonially called ironstone, and there is a vein of basalt at no great distance, but this stone does not resemble any of those. It cannot be water-borne and water-rolled; for it was among the hills, and at least fourteen miles from the sea; and there are no rounded or rolled stones on that coast, even if a stone water-rolled could ever assume such a perfect oval shape.

"It cannot have been artificially made; for the natives have no means of making such, even supposing they had any object to gain by it. In fact, they are too much pressed by the constant necessity of wandering about in search of food to have any leisure for such an amusement. No native man would or could carry any such cumbrous impediment about with him. He must have his arms free, and his body prepared for instant and vigorous action in pursuit of game, or for personal defence. Women sometimes carry in their bags small stones for the purpose of grinding hard substances, but such stones are not heavier than one pound, or two at most, and they are always of a flattened shape, and somewhat hollowed in the middle. Under all these circumstances, it seems reasonable to conclude that the native tradition is correct as applied to this stone in particular, and that it is really an aërolite. I shall be glad to hear the result of any scientific examination or analysis of it.

"Yours affectionately,

"G. F. Moore."

The Chairman remarked that the so-called egg resembled an Emu's egg very closely, especially a worn one. It was undoubtedly a boulder stone, polished by aqueous action. He then exhibited a specimen which had been brought from the South of Africa as a meteorite; it was a stone in a hollow siliceous nodule, containing loose sand. He

had seen a brooch mounted in silver, which was considered a great rarity, and supposed to be a meteorite; it was really a nodule from the coal-measures. In his opinion nine-tenths of the supposed meteorites are sham. He then read a letter from Professor Haidinger, of Vienna, relative to the Dundrum Meteorite.

Professor Haughton then read his own papers on "Some Zeolites from the Presidency of Bombay," (p. 252), and on "Some Lavas, from New Zealand" (p. 254).

The ballot was declared closed.

Messrs. W. E. L'Estrange Duffin, N. W. Townsend, R. H. Ellis, and H. P. Wall, were declared to be elected Fellows.

The meeting was then adjourned.

GENERAL MEETING, NOVEMBER 14, 1866.

A. CARTE, Esq., M. D., in the Chair.

The minutes of last meeting were read, compared, and signed; donations announced, and thanks voted.

The Honorary Secretaries presented, on behalf of the President, the Earl of Enniskillen, two specimens of fossil trees from the sandstone near Florencecourt; and also a large series of casts of the famous Mammalian fossils which were found at Eppelsheim, and are now in the Museum of Darmstadt. They stated that it is now extremely difficult to obtain these casts.

The marked thanks of the Society were voted to the President for this valuable addition to the Museum.

The following gentlemen were elected Associates of the Society for the present session:—M. Backhouse, W. Atkins, E. Wynne, A. Phelan, J. H. Moore, Luke Eiffe, and Jason Rigby, Esqrs.

Mr. A. B. Wynne's paper, "Notes on some of the Physical Features of the Ground as connected with Denudation," was read in his absence by Mr. Scott (p. 256).

Mr. Scott said that they owed a great deal to Mr. Wynne for having remembered the Society, although he was now at a distance from Ireland, being connected with the Geological Survey of India; and also for his having sent them the series of sketches with which the wall was covered, and which so fully illustrated the author's views.

Mr. Close remarked that some of the glens near Killarney were certainly not produced by marine action alone. He would suggest that ice had been the chief agent in these cases.

Dr. Whitty mentioned that he had seen caves in Arabia which he considered to be due to simple atmospheric disintegration. They were found in a region where there was no rain—at the very summit of Mount Sinai. He thought this was very remarkable.

A Fellow suggested that the caves might have been made by human agency as sepulchres.

Dr. Whitty admitted that there were traces of human action up to the very top of the mountain, as, in spite of whatever the Rev. C. Foster might say, the famous Sinaitic inscriptions were to be seen up to the very summit, Mr. Foster having stated that they did not occur nearer than a few miles from the spot. Still, however, he thought that the caves were produced by natural causes, in a granite which disintegrated easily.

Dr. Downing asked how the fact of the permanence of the inscriptions could be reconciled with the great facility with which the granite was said to yield to the denuding action of the sun and air.

Mr. Reeves said that he had often noticed on the slopes of the Alps that the rock yielded to denudation very unequally, and thought that the amount of the action was more dependent on the texture of the rock than anything else.

Mr. Close then read his paper, "On some Peculiarities in the Phenomena of Glaciation, as indicating the Nature of the Agent."

He observed that, although some more important particulars connected with the phenomena of the general glaciation seem to indicate sufficiently the nature of the glaciating agent, yet it might be worth while to mention a few others of less importance, which also seem to bear upon the question.

Any instances that he has noticed of very unsteady striation on an open, even, surface of rock, have always been on low grounds. If this be more than mere accident, it cannot be accounted for on any theory but that of land ice. The freezing point of water, or the melting point of ice, is lowered by pressure; therefore the underneath parts of the general glacier must have been softer than the upper, and probably in many places quite in a sludgy condition.

Glaciated surfaces sometimes demonstrate, in different ways, that the grinding agent must have had not only a very steady but a *very slow* motion, like that of glacier ice.

The larger furrows with rough edges, which have evidently been ploughed out by the passage of a single block, often prove that the block was held very firmly whilst being carried along. Mr. Du Noyer has observed that such furrows are sometimes fine at one end, and broad at the other, where they terminate abruptly; the broad, blunt end pointing in the direction towards which the block was moving. His explanation is evidently the true one—viz., that, when the resistance offered by the rock became too great for the firm grip in which the block was held by the mass which bore it along, the block was forced to turn, and so to leave the furrow with an abrupt end. A very remarkable ice-ground surface beside the Glenummera stream, near where it flows into Dhu Lough, Killery Harbour, affords some instances of such furrows parallel to the fine striations with which the surface is covered. One furrow is two yards long, and four inches wide at its abrupt end. Mr. Kinahan has found an instance a few miles S. E. of Westport five yards long, and five inches wide at its abrupt end.

The comparative rarity of such large furrows appears to be explained by the experiments on rock-grinding instituted by our Honorary Fellow, M. Daubree ("Bull. de la Soc. Géol. de France," 2nd Série, tom. xv., 1857). When stones were pressed by means of stiff clay on the slab to be ground, they were very soon driven into the matrix of clay, and ceased to score the slab. It is to be supposed that large blocks would soon be forced thus into the mingled mass of moraine and ice, where they would remain inoperative until, by internal movements in the mass, they were brought down again upon the floor of rock.

Some of the above particulars give evidence strongly corroborative of that supplied by others in favour of the land ice theory; though some may be of doubtful or obscure significance in respect thereto.

An animated discussion followed, in which Dr. Macalister and several other Fellows took part, and the meeting was then adjourned.

GENERAL MEETING, DECEMBER 12, 1866.

PROFESSOR JUKES, in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

PROFESSOR HAUGHTON read the following letter from the REV. W. ROBINSON, of Cambridge:—

"*Cambridge*, *Nov*. 13, 1866.

"SIR,—If the lunar theory of Professor Hansen be sound, the moon's centres of gravity and magnitude do not coincide, and consequently one hemisphere is too high for atmosphere, the other proportionately depressed. If, as seems probable, the moon has water, it must be on that depressed side, where there may be also abundance of life.

"If, by some convulsive change in the depths of the moon, the two centres were made to coincide, and if the moon herself were made to rotate in fewer hours than now she requires days for that purpose, what phenomena would be the result?

"1. As temperature depends chiefly on level, the pole of the moon we now cannot see has probably a warm, or even a steaming climate; but after the supposed change the

region about the pole (assuming an axial inclination like our own) would be ice-bound. In short, there would be a startling contrast, like that presented by the geology and the present state of our Arctic regions. 2. If there be water on the farther side of the moon, it finds its boundary where the land rises above the mean level. By the change supposed, a large part of the lunar water would be thrown to this side (which I may say, in passing, looks as though it were destined to be some time the bed of a sea), and there would be left traces of the present coast line—such traces, perhaps, as the Sahara of Africa and Arabia, and, in the same latitude, the great sandbank of the Bahamas, present to us. 3. If the moon were to undergo the changes supposed, there would be a very great difference between her two hemispheres—almost all the newest formations being in one hemisphere; which I believe is the case with our world, as far as examination has extended. 4. If the waters supposed to be on the farther side of the moon were in great part rolled to this side, they would bring with them the living creatures found upon the farther side, and spread them over this nearer hemisphere, thus creating at once new, but not extensive, land deposits; and such deposits may perhaps be recognised in South America (Darwin's 'Observations,' pp. 131, 135). 5. If a flood originating in one of the tributaries of the Rhone filled some of the houses of Martigny with mud to the second story, such a roll and rush of waters as I have supposed, would produce vast accumulations of mud, in which would be entombed the creatures that perished by the cataclysm; in short, there would be the phenomena of the Pampas. 6. It is manifest that such a change in the centre of gravity as is supposed, with its attendant deluge, would strew the globe with boulders.

"It has been commonly thought that the crust of the earth has been billowy in its movements. Have not geologists attributed too much motion to the valleys and hills, and too little to the waters? Without touching the question of earlier changes, which were many and great, I can imagine that just before our era the earth was shaped as the moon is, and rotated but once while revolving round its primary; and that among the last acts of creative power were those by which its previously divided centres were made to coincide, and diurnal rotation was imparted. This would account, I think, for all the phenomena described above, for only one of which (No. 4, if for that) are we able to account by any other theory known to me.

"But this hypothesis implies that the hemisphere of the earth, to which life was formerly limited, was then in darkness! Answer: (*a*) An extensive belt near the equator would receive light by refraction; (*b*) The region of the Pole, and perhaps other regions too, might be illuminated by such electrical means as are now found in our northern lights; (*c*) A large proportion of the present inhabitants of the earth find light enough in the night.

"I am, yours respectfully,
"WILLIAM ROBINSON.

"*Dr. Haughton, Professor of Geology, Trin. Coll. Dublin.*"

And offered some remarks of his own in illustration of it.

A discussion ensued, in which Professor Jellett and Dr. Macalister joined.

Professor Haughton also exhibited a skull, found under remarkable circumstances in sinking the south shaft of the Liffey Tunnel.

The meeting then adjourned.

GENERAL MEETING, JANUARY 9, 1867.

DR. HAUGHTON, in the Chair.

The minutes of the last meeting were read, compared, and signed; donations were announced, and thanks voted.

Mr. R. H. Scott read his "Notes of a Visit to the Granitic District of Strontian, Argyllshire" (p. 262).

The Chairman said that he was sure that the meeting had heard with great interest the paper which had been read, as its subject was one for which the Society had long

been noted. For himself, it had, of course, a more special attraction, as he himself had taken a part in the former investigations to which Mr. Scott had referred, and had analyzed the specimens sent by Sir R. Murchison. It would be a matter of great importance to ascertain exactly the composition of the striated feldspar to which allusion had been made, as he had some doubt of all such feldspars being oligoclase—a doubt which was shared by Dr. T. Sterry Hunt, so well known for his investigations in this branch of geology.

Mr. Scott then read a short notice on the Smelting of Iron by Wood Charcoal at the Lorn Furnace, Argyllshire:—

The manufacture of iron by the means of charcoal was one for which Ireland was in former times very deservedly famed. We learn from Doctor Boate that there were several furnaces of this nature throughout Ireland, which were finally blown out about the middle of the seventeenth century. This was partly owing to the rebellion of 1641, and partly to the consumption of the forests. In some parts of England, iron is refined by means of charcoal; but it may be interesting to notice a true charcoal furnace, which is now in operation. The works are at Bunawe "Lorn furnaces." The charcoal is produced from coppice woods extending over several miles of country; the yield varies from one to ten tons, according to the quality of the land. The woods are cut about every twenty-four years (in England eighteen); and such portion as would yield charcoal fitted for powder is selected and sent to the powder mills at Melfort. The iron is, as may naturally be expected, of the very lightest quality, and is entirely used by the manufacturers for tin plate. The proportion of charcoal to ore, is 1·.·2, in tons; the furnace is drawn once a day, and the weekly yield about thirty or forty tons. This is very small, compared with our English coal furnaces; but it is evident that the manufacture must be very lucrative, else it would never pay to work it at all. The furnace is constantly out of blast, perhaps because the lease has been running out. The ore used is Ulverston Hematite, and it is fluxed with limestone. The Company have works at Ulverston. The process appears to be one of some profit, as a new lease has recently been taken. It might, therefore, be a matter worth consideration whether in some parts of Ireland the process formerly carried on might not be reinstituted, if the natural wood were cultivated and cut at regular intervals for charring. It has been abundantly proved that first-class iron can be made in this country, but the cost of its production has hitherto defeated all the efforts which have been made to establish the manufacture.

The Society was then adjourned.

Anniversary Meeting, February 13, 1867.

Professor Haughton, in the Chair.

The minutes of last meeting were read, compared, and signed; donations announced and thanks voted.

The ballot was declared open. Messrs. Dixon and Macalister were appointed scrutineers for Members of Council and General Officers.

Mr. Reeves, as Honorary Secretary, read the Annual Report (p. 267).

Mr. Reeves read Mr. J. J. Lalor's paper on—" A Physical Theory to account for the Configuration of Continents":—

" The subject I bring before you this evening deserves some apology on my part for the crudeness of the model which I shall have to submit to you, as a slight attack of illness prevented me completing in as perfect a form as I could have wished the globe I have constructed for your inspection.

" I shall not at present enter into the various solutions propounded for the phenomena of the Cosmos, as generally known through geographical and other recent researches, but ask your attention for a few moments, whilst I state, as briefly as possible, the basis of my theory. I take it to be an universally admitted fact, that the world as at present is not the world of a bye-gone age, and that great changes have taken place during the pre-historic age. And one fact amongst the few recorded being, that God made the world; another, that after a period of much favour man abused the grace of God to

such an extent, he deemed it wise to destroy the world and all upon it, reserving only a few individuals saved through his mercy. Beyond this I shall not refer to Holy Writ on this occasion.

"I shall now endeavour to suggest the reconstruction of the world, as it *may* have existed previous to that dreadful occurrence; for which purpose permit me to submit for your consideration that beautiful contrivance of modern skill, 'Johnston's Chart of the World, on Mercator's Projection,' by which you perceive Greenland prominently forward, and which I conceive to be the only portion of the pre-aquous world in its original position. By joining the northern portion of America to it, and bringing the old world a degree of latitude upwards, and joining them thereto, and bringing the southern portions of South America forward, we unite the old and the new worlds into one continuous land.

"It now only remains to restore Australia into its supposed original position between Africa and Asia, to complete an universal whole, and which I have now the pleasure, Mr. President, to submit to you and the Society in the globe I have been at the pains to construct.

"And here let me tender my thanks to our eminent publishers, Messrs. Hodges and Smith, for their great kindness in procuring me an unmounted copy or skin, which materially assisted me in the construction of my model.

"I submit, Mr. President, that, if my views be correct, they will most satisfactorily account for the distribution of plants and animals throughout the globe, reconciling conflicting theories as to the age of the world, account for the various coal deposits and fossiliferous remains found on the highest mountain ranges, and in the lowest depths to which the miner's avocations call him, conform the glacial with the volcanic theories, and prove the means of reconciling the various hypotheses at present disturbing the scientific and Biblical sections of society.

"In conclusion, Mr. President and Fellows of the Royal Geological Society, I deem it due to you to suggest an account of the disturbing causes whereby I am led to believe the disjointing of the two hemispheres may have occurred. Let us suppose the Almighty, in his great wrath, for a moment removes the attractive influence of the sun—instantly the world would drop out of its orbit, causing the waters to be disturbed to such an extent as to completely flood the surface of the land—the latter, removed from the action of the atmosphere and sun's rays, cooled to such an extent as to cause all the waters to solidify to ice. Permit the rays of the sun to exercise their influence once more—the frozen waters expand under its rays, force asunder the earth, and eventually melting, the waters rush with incalculable force towards their original position, carrying along with them the huge glaciers, tearing through the valley, rubbing the hill sides, and, sweeping all mineral matter with them in their impetuosity, leave us the barren hills of northern latitudes, depositing the superabundant soil in the Tropics, a source of everlasting wealth to them. The fossiliferous remains, being the skeletons of animals and plants, petrified before decomposition set in, remain to the present age for our wonder and delight."

Professor Haughton and Dr. Macalister made some remarks.

The ballot was declared closed. The scrutineers declared the result of the ballot for Officers and Council for the ensuing year (p. 271).

The scrutineers declared the following gentlemen were elected Fellows:—

Sir Robert Kane, Wickham, Dundrum: proposed by Professor Jukes; seconded by W. Frazer, Esq., M. D.

J. M'Carthy Meadows, Wolf Hill, Athy: proposed by J. O'Kelly, Esq.; seconded by Professor Jukes.

Robert Forster, Esq., C. E., University Club: proposed by R. S. Reeves; seconded by R. H. Scott, M. A.

George Black, Esq., C. E., Belfast: proposed by Professor Downing; seconded by Rev. S. Haughton, M. D.

Clement Dunscombe, Esq., M. G. W. Railway, proposed by Dr. Haughton; seconded by Professor Downing.

John E. Gore, Esq., C. E., 25, Merrion-square, South: proposed by Dr. Haughton; seconded by Professor Downing.

The meeting then adjourned.

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